COMMONWEALTH OF PENNSYLVANIA

DEPARTMENT OF INTERNAL AFFAIRS

GUIDEBOOK TO THE GEOLOGY OF THE PENNSYLVANIA TURNPIKE

CARLISLE TO IRWIN

By

Arthur B. Cleaves and Robert C. Stephenson

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DEPARTMENT OF INTERNAL AFFAIRS
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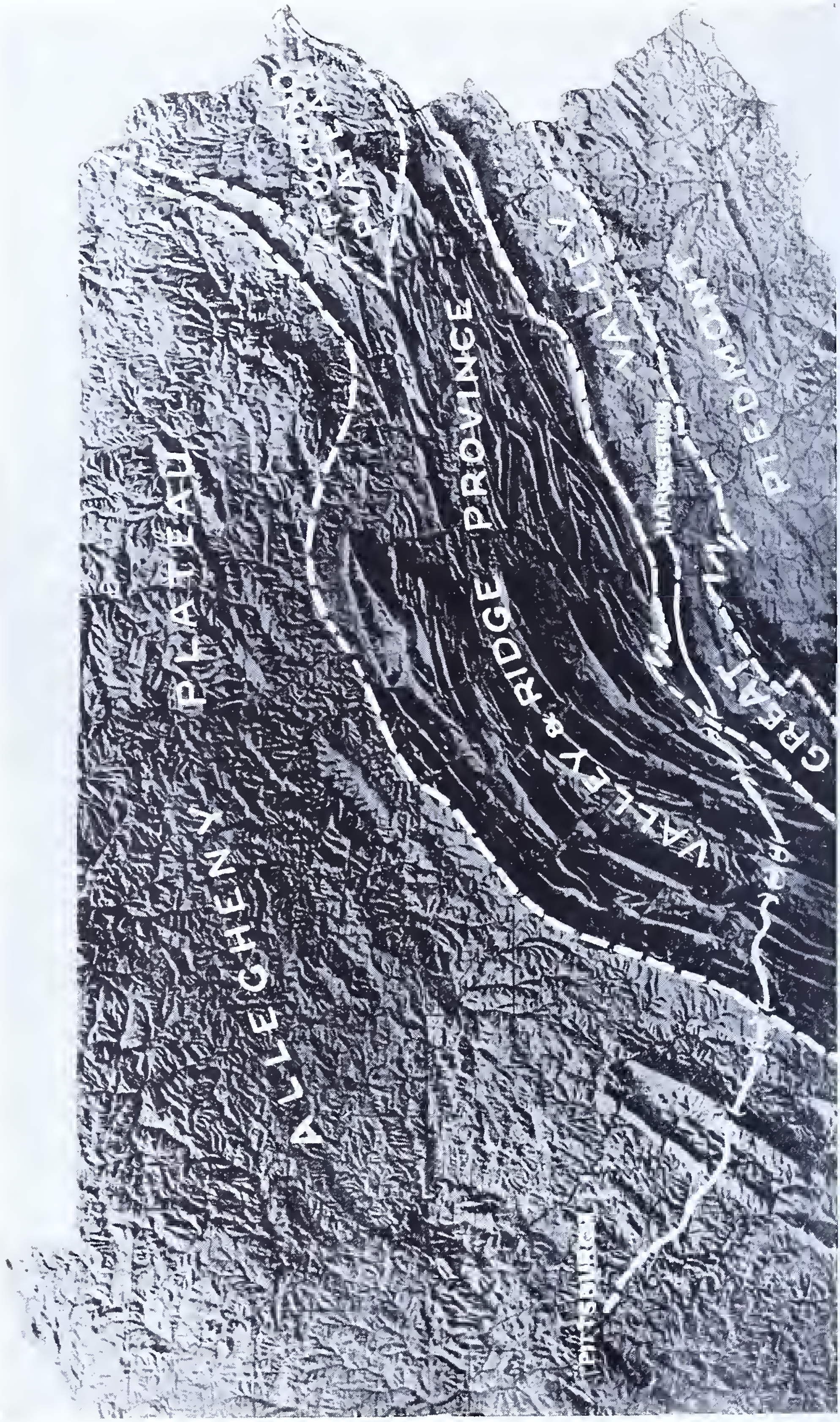

PLATE 1. Relief map of Pennsylvania showing physiographic provinces and the route of the Turnpike.

GUIDE TO THE GEOLOGY
OF THE
PENNSYLVANIA TURNPIKE: CARLISLE TO IRWIN

BY

ARTHUR B. CLEAVES AND ROBERT C. STEPHENSON

Introduction

LOCATION AND FEATURES

The geology of the Pennsylvania Turnpike between Carlisle and Irwin is described in this report. This section of the turnpike, Figure 1, which embodies the most modern principles of highway construction, is 160 miles in length and was completed in 1941 at a cost of more than $70,000,000. Movement of traffic along the four-lane highway is facilitated by the elimination of grade crossings and local entrances, and the by-passing of towns and cities. Access to the Turnpike is limited to conveniently spaced clover-leaf interchanges (pl. 2); the alignment is designed to permit uninterrupted travel at uniform speed. Grades are held to a maximum of three percent, and seven mountain-piercing tunnels (pls. 3 and 4) eliminate about 9,000 feet of climbing which would be necessary to traverse the route without benefit of tunnels. The maximum curvature is six degrees with a radius of approximately 1,000 feet.

HISTORICAL BACKGROUND

From Middlesex westward to Blue Mountain Tunnel the Turnpike traverses Cumberland (Great) Valley, which has long played an important role as a transportation route.

In Colonial days, when hostile Indians blocked passage via the water level route across western New York, thousands of pople passed through the Great Valley moving westward through Cumberland Gap to the frontier. In these early days this route also served as a principal trade channel for goods moving across the mountains. During the Civil War the Great Valley, with its low rolling terrain, was of strategic military importance. The valley was an excellent military route and was the scene of a number of major military campaigns. Its fertile farm lands contributed food to these campaigns.

From the earliest Colonial days the need for a link between the west and east in Pennsylvania was recognized. As early as 1755 Col. James Burd, a Pennsylvania engineer and military leader, was instructed to cut a wagon road from Shippensburg to Pittsburgh to aid in supplying General Braddock in his French and Indian War campaigns. Later, in 1758, the Forbes expedition pushed westward along much the same line as the present Turnpike. The building of this road ceased near Bedford with news of Braddock's defeat. Just a century before the creation of the present Pennsylvania Turnpike Commission, the State General

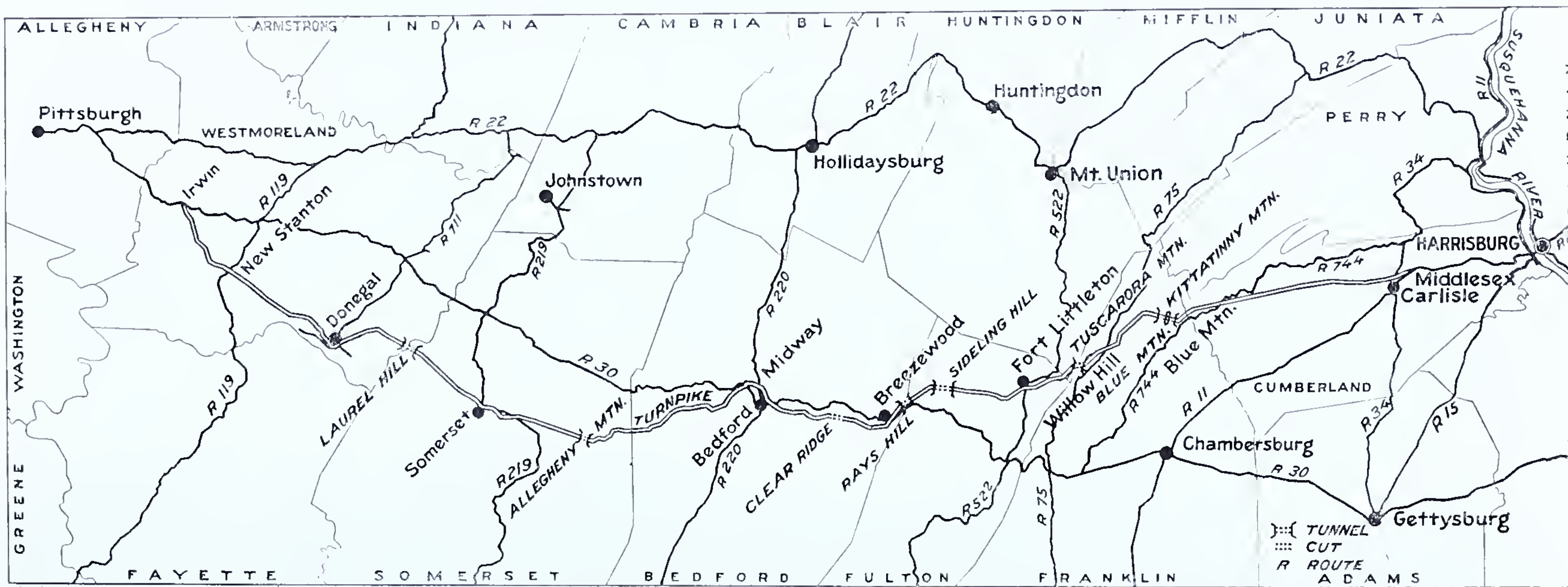

Figure 1. Map of the Turnpike showing tunnels, principal cuts, interchanges, and connecting routes.

Assembly in 1837 authorized the first survey of a southern Pennsylvania railroad route. Additional surveys were made in 1844 by the Pennsylvania Railroad before adopting its Juniata River route.

In 1854 the Pennsylvania Assembly granted a charter to a company which proposed to build a railroad connecting the Broad Top coal field with the East and utilizing in part the previously surveyed south line. Though the project was abandoned before completion because of construction difficulties, the charter was maintained chiefly through the efforts of Col. James Worrall.

Andrew Carnegie fought the Pennsylvania Railroad bitterly for many years in an unsuccessful effort to win lower freight rates for Pittsburgh iron and steel moving to the eastern seaboard. Carnegie welcomed the opportunity in 1883 to back William H. Vanderbilt of the New York Central, who organized a company to build the South Penn Railroad to compete with the Pennsylvania across the mountains. This move was taken by Vanderbilt in retaliation when the Pennsylvania Railroad threatened to build a road along the west bank of the Hudson to compete with the New York Central.

To initiate this project an extensive survey was carried out by an engineering corps of 300 men. One thousand square miles of topographic mapping were completed and 5,000 miles of lines were run before the route was finally adopted in the Fall of 1883. By the end of the summer of 1885 more than 60 percent of the grade was established, 4½ miles of tunnel driven (although no individual tunnel was completed), and a number of bridges built by the army of workers poured into the construction. The project, which had flourished so quickly, died almost overnight when pressure from financiers culminated in the sale of the South Penn to the Pennsylvania Railroad in the fall of 1885 and the immediate abandoning of the project.

Several unsuccessful attempts were made to revive the South Penn Railroad in the period between 1885 and 1937. The General Assembly of 1937 authorized the creation of the Pennsylvania Turnpike Commission, giving it authority to construct, operate, maintain, and finance a self-liquidating super-highway between Middlesex and Irwin, utilizing to a large extent the old South Penn right-of-way. Twenty months were required to complete the Turnpike—a project which under normal construction practices would have taken three to four years. Approximately 26,000,000 cubic yards of earth and rock were moved and 4,300,000 square yards of reinforced concrete laid during this short construction period.

GEOLOGIC STUDIES

Construction of the Pennsylvania Turnpike has contributed considerable information on the classic geology of the Appalachians. Tunnel construction, particularly, afforded an unprecedented chance to study in continuous exposures the rocks which constitute the mountain ridges. Excellent exposures of rocks in cuts and water gaps along the Turnpike offer wonderful opportunities for detailed geologic studies.

Early in the construction of the Turnpike the need for geologic work was recognized. A. B. Cleaves and Joseph M. Gorman, on leave from the Topographic and Geologic Survey, served in the capacity of geologists

for the Commission during the period of construction. Appraisal of mineral lands traversed by the Turnpike and the engineering of tunnel construction were two phases of activity which were especially dependent upon geologic investigations.

Topographic and Geologic Survey Bulletin G 20 "Guidebook to the Geology of the Pennsylvania Turnpike", by A. B. Cleaves and G. H. Ashley, was prepared, following the completion of the super-highway, to serve as a popular guide to the exposed geology. This bulletin met with wide demand, and, with the edition nearly exhausted, it was decided to publish a revised and expanded guidebook. The present guidebook, which incorporates some additional field work by A. B. Cleaves, features geologic strip maps drawn on a topographic base; the maps and text were largely organized for publication by Robert C. Stephenson.

Data incorporated in this report were used in preliminary form in guidebooks for the Eleventh Annual Field Conference of Pennsylvania Geologists, May 1948, and the Field Trip of the Eastern Regional Meeting, American Association of Petroleum Geologists, October 1948. In turn, certain data presented by the Pittsburgh Geological Society in the above-mentioned A.A.P.G. guidebook were incorporated in this bulletin in its final form.

ACKNOWLEDGMENTS

The writers are indebted to the many engineers and geologists who cooperated or advised in the geologic investigations which were begun with the inception of the Turnpike. The Pennsylvania Turnpike Commission has generously cooperated in supplying data and, in the summer of 1947, transportation to facilitate the additional field work. Particular acknowledgment is due Joseph M. Gorman, who ably assisted Cleaves from 1937 to 1940, during the period of engineering and construction on the Turnpike.

Professor Frank M. Swartz, Pennsylvania State College, supplied much information and many helpful suggestions. The writers are particularly indebted to him for detailed information on the Cambro-Ordovician rocks in the Everett area and for the measured section and generalized cross section of the Bedford Narrows. Members of the A.A.P.G. Field Trip Committee of the Pittsburgh Geological Society are thanked for their constructive criticisms. The Pennsylvania Historical Commission supplied historical data.

The excellent work of Marchant N. Shaffner of the Survey Staff in preparing the geologic strip maps is recognized by the writers. To him is due particular thanks for this and other assistance. Miss E. V. Adams and Miss A. C. Sangree of the Survey were very helpful during the editing.

PHYSIOGRAPHY

The Turnpike traverses two physiographic provinces—the Ridge and Valley province, and the Allegheny Plateau. Plate 1 (facing page 1) is a relief map of Pennsylvania showing the route of the super-highway with respect to the physiographic features.

RIDGE AND VALLEY PROVINCE

From Middlesex to Allegheny Tunnel the highway crosses the Ridge and Valley province. The striking topography of this province is the result of a complex geologic history. Over 25,000 feet of sediments deposited in this area have been sharply deformed into a parallel series of northeast trending folds. The folding was intense; it is estimated that 81 linear miles of rock strata originally horizontal have been compressed to 66 linear miles in the eleven principal folds of this province. The folded area was gradually uplifted, and eroded by downcutting streams. The variations in resistance of the folded strata to erosion resulted in the formation of the alternating ridges and valleys. The valleys are typically floored by limestones and less-resistant shales, whereas such resistant rocks as the Tuscarora sandstone form the ridges.

Travelling westward on the Turnpike to Blue Mountain Tunnel one crosses the famous Great Valley, which extends from New York southward to Alabama. In Pennsylvania the southern portion of this valley is given the name Cumberland Valley. On the Turnpike there is a fine panorama of this valley, bordered on the southeast by South Mountain (a northern continuation of the Blue Ridge Mountains of Virginia) and on the north by Blue or North Mountain (pl. 5A), as it is variously called.

The Ridge and Valley province is about 100 miles wide in the area traversed by the Pennsylvania Turnpike. In some places the Turnpike route takes advantage of water gaps, as at Bedford Narrows, where streams have breached the mountain ridges. Elsewhere it skirts the ridge-forming members of plunging folds, as at Wills Mountain. Where the route is confronted with unbroken ridges, these barriers are broken by tunnelling. Blue Mountain, Kittatinny Mountain, Tuscarora Mountain, Sideling Hill, and Rays Hill are breached by tunnels. For comparison, Route 30 crosses Sideling Hill at 2,200 feet elevation and crosses Tuscarora Mountain at 2,100 feet; the Turnpike penetrates these ridges at 1,300 feet and 1,000 feet, respectively.

ALLEGHENY PLATEAU PROVINCE

At Allegheny Tunnel the Turnpike penetrates the imposing topographic barrier, the Allegheny Front, which marks the boundary between the Ridge and Valley and Allegheny Plateau provinces. From this point westward the Turnpike is in the plateau country which is underlain almost entirely by rocks of Pennsylvanian age. This area contains valuable coal and clay resources.

From Allegheny Tunnel to Chestnut Ridge the highway crosses a series of mountains and high plateaus in the Allegheny Mountain section of the plateau province. The average elevation of the Turnpike from Allegheny Tunnel to Laurel Hill Tunnel is nearly 2,300 feet above sea level, and the low grades of the highway are maintained by traversing high divides. The rocks underlying the Allegheny Mountain section are very gently folded, except on Laurel Hill and Chestnut Ridge. These ridges are topographic expressions of sharply folded anticlines. Rocks as old as Devonian in age are exposed where these ridges are deeply dissected.

West of Chestnut Ridge the surface of the Appalachian Plateau dips gently to the west in an area characterized by broad-topped hills, deeply and roughly dissected by V-shaped valleys. The coal beds exposed on the flanks of Chestnut Ridge dip westward into the Pittsburgh-Huntingdon structural basin at a rate more rapid than the land surface slopes, so the lower coals are deeply buried in the southwestern corner of the state.

General Geology

general statement

Rocks are divided into three great classes according to their origin. These are:

1. *Igneous*—rocks such as granite and lava which have solidified from a molten condition.
2. *Sedimentary*—rocks laid down as sediments through the agency of water, wind, or glaciers. Sandstones, shales, and limestones are examples.
3. *Metamorphic*—rocks derived from pre-existing sedimentary or igneous rocks by mineralogical, chemical, and structural alteration due to heat and pressure. Limestone may be metamorphosed to form marble, and shale will yield slate.

The rocks encountered along the Turnpike are of sedimentary origin, and although subjected to considerable pressure during the time of folding, lack evidence of marked metamorphic effects. The rock sequence consists of an interbedded series of limestones, shales, sandstones, and conglomerates which were deposited in shallow seas as beds of limy ooze, muds, or sands, or on the land along rivers, in lakes, lagoons, or swamps. The sediments were deposited as material derived from the mechanical and chemical disintegration of pre-existing igneous, sedimentary, and metamorphic rocks, from the remains of animal and plant life, and from chemical precipitation. None of the strata observed along the Turnpike are thought to have been formed by glacial or wind action.

The most noticeable feature of sedimentary rocks is the stratification, or arrangement in layers. A *stratum* is a layer separable along bedding planes from layers overlying and underlying, the separation resulting from an interruption in deposition or a change in the physical character of the material deposited. Stratification may be caused by a change in color, size, or composition of the sediments.

geologic history

The bedded sedimentary rocks which we see along the Pennsylvania Turnpike accumulated over a period of some 225 million years. To discuss intelligently the history and general relations of these rocks it is necessary to outline briefly the principles governing the subdivision of these rocks by geologists.

Geologic time is subdivided into *eras,* which are in turn broken down into successively smaller time divisions known as periods, epochs, ages,

and stages. These divisions, names applied to the rocks of each division, and typical examples are given below:

TIME	ROCKS	EXAMPLES
Era	Sequence	*Paleozoic*
Period	System	*Silurian*
Epoch	Series	*Niagaran*
Age	Group	*Clinton*
Stage	Formation	*Rose Hill*

The age of the earth has been estimated to be about 2 billion years, but rocks along the Turnpike are those belonging to the Paleozoic Era and were deposited between 450 and 225 million years ago. Old though they are, the rocks along the super-highway occupy a relatively recent chapter

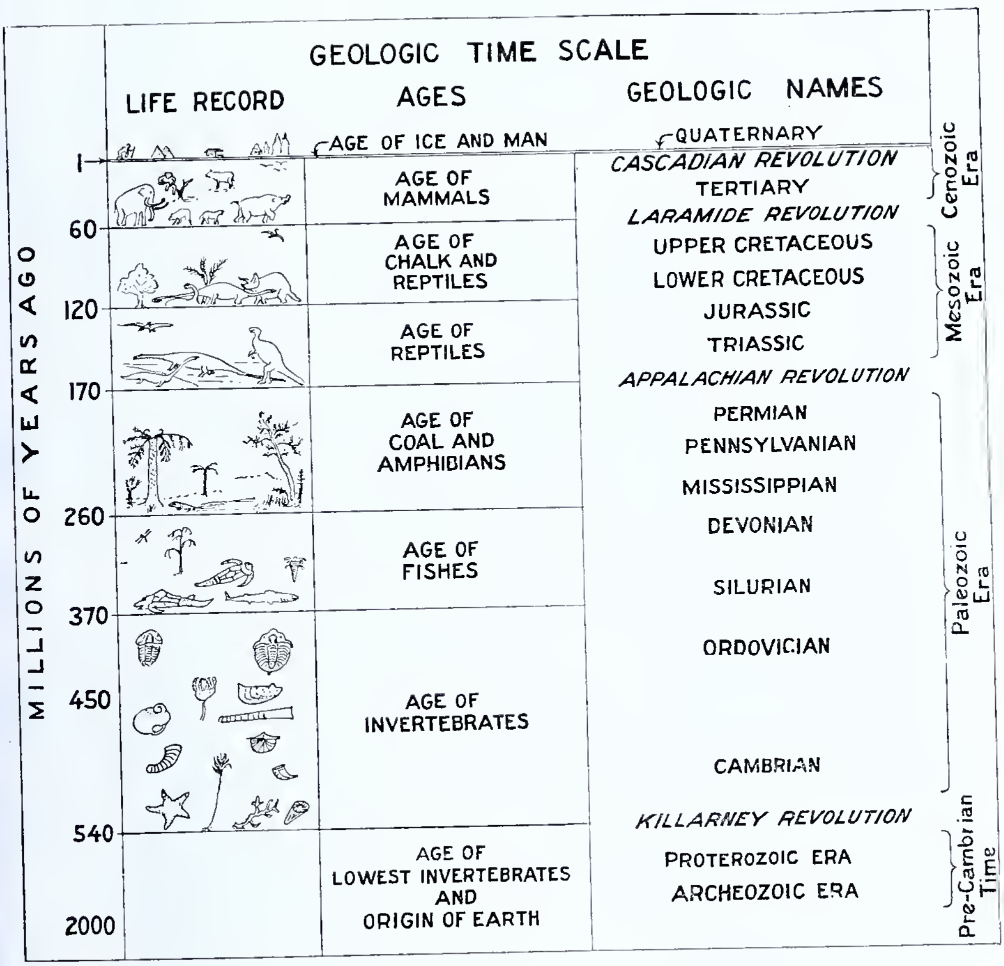

FIGURE 2. Geologic time chart.

in the entire geologic history of the earth. Figure 2 is a geologic time chart which shows the major subdivisions of geologic time and their estimated duration. Figure 3 is a geologic map of Pennsylvania, and

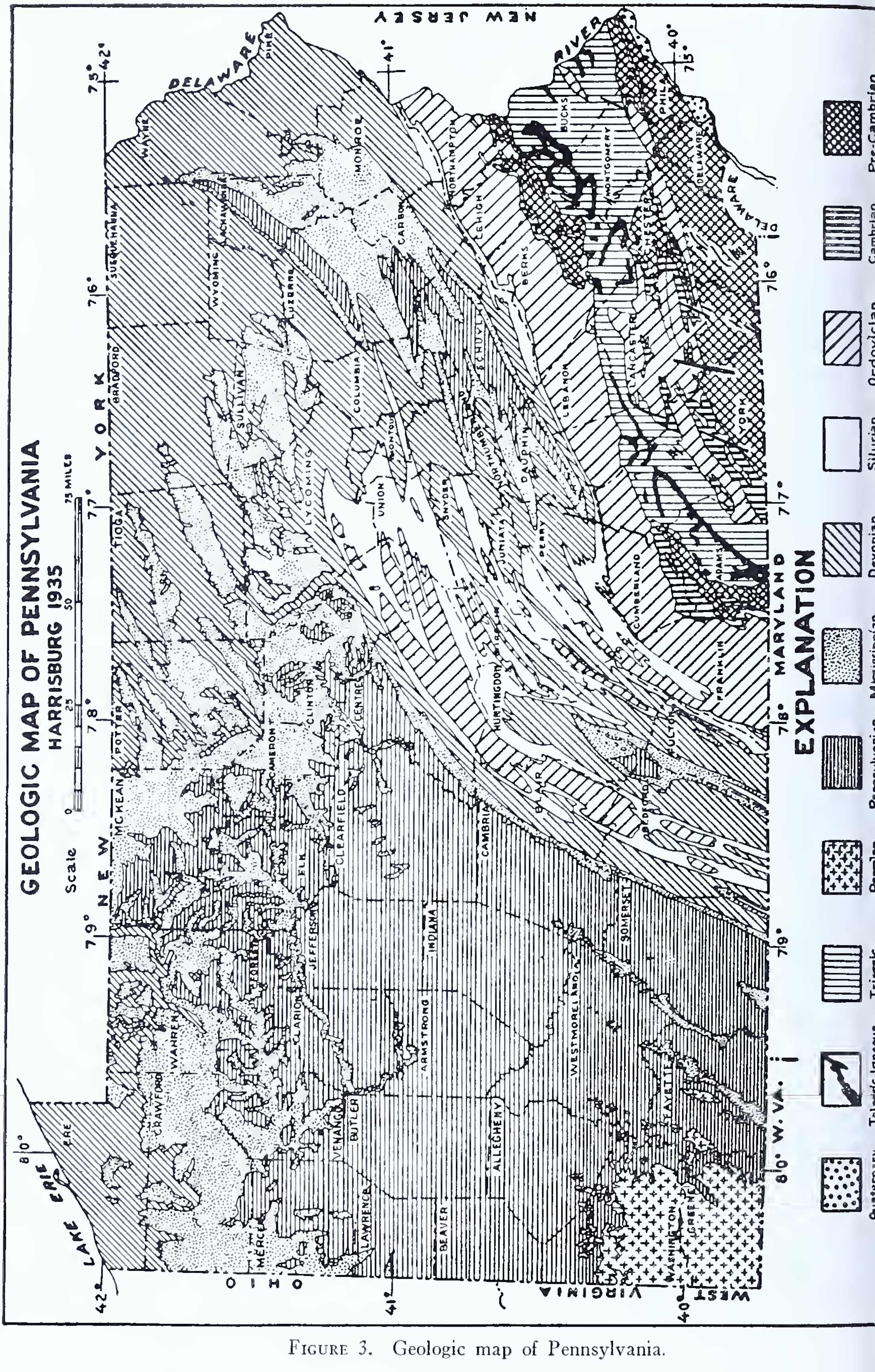

FIGURE 3. Geologic map of Pennsylvania.

Figure 4 shows stages in the geologic development of the rocks in Pennsylvania.

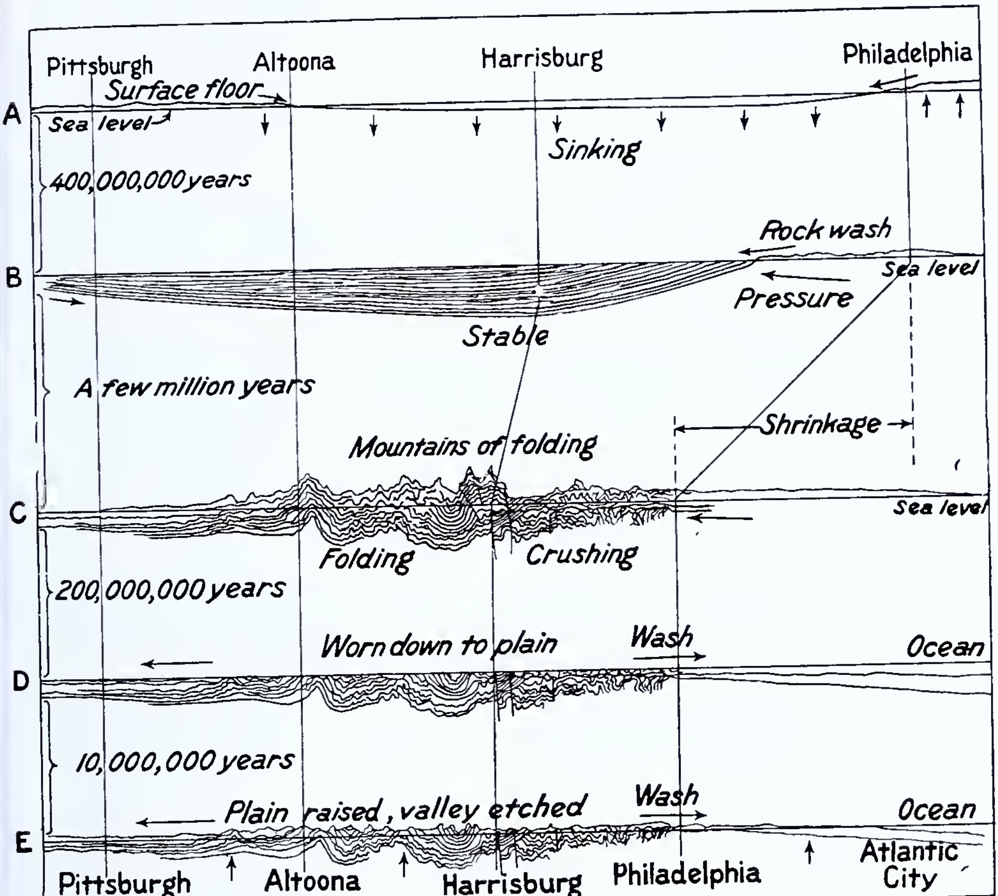

FIGURE 4. Sketch showing stages in the geologic development of Pennsylvania.

Depositional History

Deposition of the rocks under consideration began in Cambrian time throughout the shallow Appalachian trough which extended from the Gulf of the St. Lawrence southward into Alabama. Sediments were washed into this shallow sea from highlands to the northwest and from the ancient land mass of Appalachia which roughly paralleled the present Atlantic coast line. On the sandy beaches of the continent, Appalachia, accumulated the Cambrian sandstones now exposed on the flanks of South Mountain, which may be seen in the distance from the eastern end of the Turnpike. As deposition progressed the seaway deepened, and a great thickness of limestones accumulated during Cambro-Ordovician times. The Ordovician deposits attained a maximum thickness of one and one-half miles in central Pennsylvania. The oldest rocks exposed on the Turnpike are the Cambrian sediments east of Bedford.

During late Ordovician and early Silurian time there was uplift of the land mass to the east, and the seaway became more shallow. The resulting sediments graded from coarse sands and gravels in the vicinity of

Harrisburg, westward into fine sands, siltstones, shales, and locally impure limestones. Late in Silurian time deposits of red shale and sand typical of east-central Pennsylvania graded westward into rocks containing bedded salt deposits which are commercially important in New York and Michigan.

The Devonian sediments were poured out in great volume over the platform of sediments in the broad Appalachian trough, accumulating as sands, clays, and limestones in shallow estuaries and seas. Delta and flood plain deposits were also common.

The Mississippian rocks of the Turnpike area represent a vast accumulation of detrital material, which has an aggregate thickness of over 4,000 feet in the Harrisburg area but thins rapidly to the west. The system includes coarse conglomerates, sandstones, red and variegated shales. In southwestern Pennsylvania there are limestone and sandy limestone interfingering from the south with these sediments.

Deposition in the Paleozoic Era was climaxed in Pennsylvania with the formation of the Coal Measures. The coals of the Pennsylvanian System of rocks constitute the greatest mineral resource of the Commonwealth. The deposits of this period accumulated on a broad, flat platform which stretched from Pennsylvania westward to Illinois. Much of the deposition on this platform was accomplished by the scouring and filling action of streams to produce a complex alternation of sandstones, siltstones, and shales. There were widespread areas of swamp lands, densely covered with a luxuriant growth of scale-bark trees, horse-tails, and ferns that were subsequently buried and transformed into coal. Lagoons formed locally, and thin limestone deposits formed in the clear, quiet waters.

Travelling westward along the Turnpike one gets a distant view of Pennsylvanian deposits to the north of the highway, between Sideling and Rays Hill tunnels where down-folding of the Broad Top synclinorium preserved the coal beds of the Broad Top field from complete erosion. Westward from Allegheny Tunnel the Allegheny Plateau is covered by a thick veneer of Pennsylvanian deposits.

As an anticlimax to this grandiose Pennsylvanian sedimentation, and closing the Paleozoic Era, we have the deposition of the Permian (or Upper Barren Coal Measures). The exact geologic age of these beds is not conclusively proven. Preserved in southwestern Pennsylvania, and capping the higher hills at the western extremity of the Turnpike near Irwin, are interbedded sandstones and shales with several low-grade coals constituting the lower part of the Dunkard series. These beds represent the youngest rocks exposed along the Turnpike.

In resumè, the youngest rocks are exposed at the Irwin end of the Turnpike, the oldest between Bedford and Everett. Table 1 gives the succession of rocks seen on the Turnpike; exact thickness, where given, indicate actual measurements in tunnels, cuts, or diamond drill holes.

Structural History

We have discussed the origin of the rocks along the Turnpike, how the sediments accumulated in a long, narrow, subsiding trough, known as the Appalachian geosyncline. The subsidence of this trough was the first

TABLE I. General character of strata exposed along the Turnpike and the mineral resources found within these rocks in Pennsylvania

SYSTEM	SERIES	SUBDIVISIONS OF STRATA	THICKNESS IN FEET†	GENERAL CHARACTER OF STRATA ALONG TURNPIKE	PENNSYLVANIA MINERAL PRODUCTS
PERMIAN	DUNKARD	WASHINGTON		Interbedded sandstone and shale chiefly, thin limestones, a few coals, locally reddened. Only lower 25 feet of this group seen along Turnpike	Coal, sandstone, limestone, shale, clay
PENNSYLVANIAN	UPPER PENNSYLVANIAN	MONONGAHELA (Upper Productive Coal Measures)	250-400	Limestone, shale, and sandstone interbedded, with several workable coal beds. Waynesburg coal at top and Pittsburgh coal at base	COAL (BITUMINOUS), limestone, sandstone, shale, clay
		CONEMAUGH (Lower Barren Coal Measures)	650	Red and gray shale and coarse sandstone, with occasional thin beds of limestone, coal, and low-grade fire clay. Coals only locally minable	COAL (ANTHRACITE, bituminous), sandstone, shale, limestone, clay, oil, gas
		ALLEGHENY (Lower Productive Coal Measures)	280	Shale and sandstones, with some limestone interbeds and economically important coals and fire clays	COAL (BITUMINOUS, ANTHRACITE), CLAY, sandstone, limestone, shale, iron, oil, gas
	POTTSVILLE	POTTSVILLE: HOMEWOOD, MERCER, CONNOQUENESSING	50-250	Coarse, quartzose sandstone or conglomerate with intermediate shale carrying thin coals locally	CLAY, COAL (ANTHRACITE, bituminous), SANDSTONE, GLASS SAND, shale, iron, oil, gas
MISSISSIPPIAN		MAUCH CHUNK, GREENBRIER	262-[illegible]	Red and green shale with green, flaggy sandstone. Blue, fossiliferous limestone near base	LIMESTONE, shale, sandstone, manganese, iron
		LOYALHANNA	50	Siliceous, cross-bedded, blue gray limestone	CRUSHED STONE, building stone
		POCONO, BURGOON	1,230	Massive, hard, gray and blue, cross-bedded sandstones	Oil, gas, building stone
DEVONIAN	UPPER	CATSKILL (HAMPSHIRE)	4,500	Red sandstones and shales with interbedded green shales and sandstone. These beds interfinger with the underlying Chemung and Portage groups, but are themselves nonmarine	Oil, gas, flagstone, sandstone, shale
		CHEMUNG	2,20[illegible]	Alternating greenish gray to brown sandstones and shales	OIL, GAS, flagstone
		PORTAGE: BRALLIER, HARRELL, BURKET	2,100	Brown and gray to black shales and sandstones. Tully limestone at base is now considered uppermost Middle Devonian	Gas, shale
	MIDDLE	TULLY			
		HAMILTON: MAHANTANGO	[illegible]	Massive to thin-bedded, gray to tan sandstones interbedded with variegated shales. Marcellus black shale at base	Stone, shale
		ONONDAGA (NEEDMORE)	150	Black and gray shales, limestones at top	Iron, limestone, gas
	LOWER	ORISKANY: RIDGELEY, SHRIVER	200	Consists of white to bluish gray calcareous (Ridgeley) sandstone, and blocky, grayish black, impure cherty limestone (Shriver)	GLASS SAND, molding sand, clay, stone
		HELDERBERG: NEW SCOTLAND, COEYMANS	75	Cherty limestone (New Scotland), crystalline limestone (Coeymans)	LIMESTONE, lead, zinc, clay, stone
SILURIAN	UPPER	KEYSER	250	Blue gray limestone, transitional from Silurian to Devonian	LIMESTONE
		TONOLOWAY	700	Bluish-gray thin-bedded shaly limestone, in places entirely gray shale	
		WILLS CREEK	209	Soft, thin, green and yellow shales, calcareous at top. Very locally to dove-gray and red shales	Rock salt
		BLOOMSBURG	207	Soft thin-bedded, unfossiliferous red shales, interbedded with sandstone	Brick shale
	MIDDLE	MCKENZIE	259	Green to gray limestone, interbedded with greenish shale that weathers brown. Many fossils	
		KEEFER	48	Massive sandstone to light-buff, fossiliferous quartzite	
		ROSE HILL (CLINTON)	575	Mostly thin-bedded red shale with thin sandstone interbeds	Iron ore, brick shale
	LOWER	TUSCARORA	395	Heavy-bedded, white and gray sandstone and quartzite. A hard, resistant ridge-forming formation	GANISTER (silica refractories), building stone
ORDOVICIAN	UPPER	JUNIATA	608-1,050	Red sandstone and shale	
		BALD EAGLE	119-550	Greenish gray, massive to medium-bedded sandstone	Building stone
		MARTINSBURG, REEDSVILLE†, TRENTON*	1,500 (1,100) (300)	Brown to buff-colored shales interbedded with thin brown sandstones	SLATE, CEMENT, LIMESTONE, stone, brick shale
	MIDDLE	BLACK RIVER	210	Thick-bedded granular to non-granular gray limestone, fossiliferous. Includes chemical limestones	LIMESTONE
		CHAZY† (STONES RIVER)	180	Thick-bedded finely crystalline, dark limestone. Some fossils	LIMESTONE
	LOWER	BEEKMANTOWN:			
		BELLEFONTE*	1,000	Thick-bedded, gray, crystalline dolomite, cherty	Stone
		NITTANY†	1,000	Thick-bedded gray crystalline dolomite; fossiliferous chert	Zinc, lead, iron, stone
		MINES*	250	Thick-bedded, bluish-gray dolomite characterized by oolitic chert	White clay
CAMBRIAN	UPPER	GATESBURG*, ORE HILL*	1,500 ([illegible])	Thick-bedded, bluish, coarsely crystalline dolomite with interbeds of quartzite	Iron, white clay
		WARRIOR*	1,200	Thin- to thick-bedded, blue to bluish-gray, fine-grained dolomitic limestone	LIMESTONE

† Exact thickness figures commonly indicate specific measurement of beds which has been made in tunnels, cuts, or diamond drill holes.

* Divisions recognized in the Bedford area.

step in the structural history of these rocks which we see reflected in our mountains of today.

In geologic history, the sequence of deposition, folding, uplift, and erosion has been repeated many times and has given rise to mountain chains such as the Alps, Himalayas, Andes, and our own Rockies, as well as the Appalachians. Although mountain-building has been restricted to limited areas of the earth's crust at any one time, the orogenic (mountain-making) forces have a far-reaching effect on the character, composition, and quantity of sediments being deposited. At the end of Paleozoic Time, climaxing the deposition of the thick sequence of sediments in the Appalachian trough, occurred such a period of mountain-making, resulting in the formation of the Appalachians. A tremendous lateral pressure developed along the eastern margin of the geosyncline, and thousands of feet of rock were compressed into vast folds, much as one would produce in wrinkling a pile of blankets by pushing on one side. The beds arched up into *anticlines* and bowed down into *synclines*. Where pressures were too great the strata broke, and one part slid over the other along the fracture or *fault*. Examples of anticlines, synclines, and faults will be seen along the Turnpike. In Figure 4 the evolution of the Appalachians is shown in cross section. This period of folding was followed by one of uplift and erosion resulting in the physiographic features which we see today and which were discussed previously in this report. The vastness of the folds seen in the Ridge and Valley province and the nature of the force which produced the great lateral shortening have continued to provide fertile fields for geologic thinking.

Engineering Geology

The rocks traversed in Turnpike construction produced many and varied engineering problems. Although it was originally intended to use geologists for only limited phases of construction, such as the tunnel work, it was soon found advisable to have the continuous services of two men to interpret and advise on the many geologic aspects involved in construction (fig. 5). The aid of the geologist was sought particularly in the driving of the tunnels, excavation of deep cuts, exploratory drilling, and appraisal of mineral lands traversed by the highway.

Some of the features of the Turnpike construction which are related directly or indirectly to geology are described in this section of the report. There is vast wealth of data which was accumulated on the engineering geology of the tunnels. These data are being compiled as a supplement to this report.

TUNNELS

When the Old South Penn Railroad ceased work in 1885, nine tunnels, partially excavated, were abandoned. Not long after surveys by the Pennsylvania Turnpike Commission were initiated, it became apparent that two of these tunnels were not necessary for the successful construction of a modern super-highway and could be converted into open cuts. Table 2 shows the sequence of tunnels from east to west, and the stage

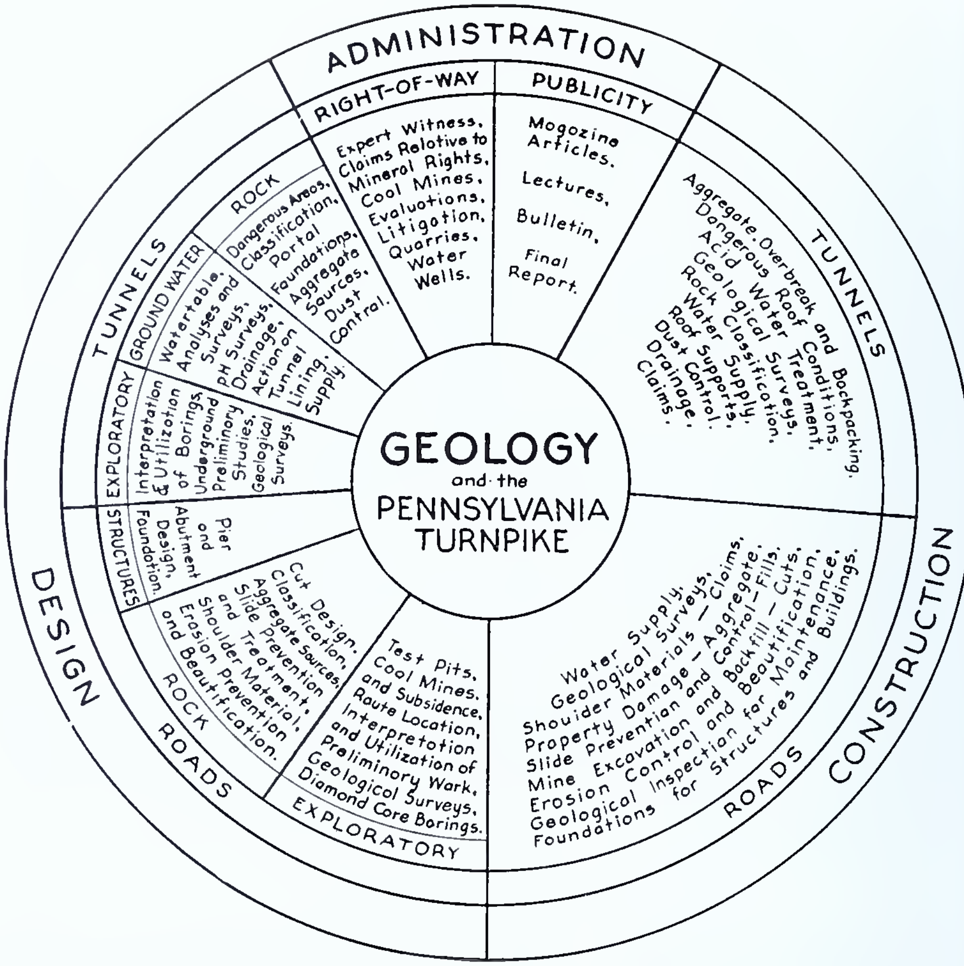

Figure 5. Chart showing the relationship of geology to the various aspects of Turnpike construction.

of completion of each when the Turnpike Commission took over is as follows:

Table 2. *Status of South Penn Railroad tunnels at the beginning of Turnpike construction.*

Tunnel	Length (feet)	Driven Section: West Heading (feet)	Driven Section: East Heading (feet)	Undriven Section (feet)
Blue	4178	1141	1863	1174
Kittatinny	4572	1646	2375	551
Tuscarora	5167	1785	1930	1452
Sideling	6623	1572	1672	3379
Rays	3396	1088	1307	1001
Allegheny [1]	5907			5907
Negro [2]	1091	48	688	355
Quemahoning [3]	735			——
Laurel [4]	4368	813		3555

[1] *Old tunnel not used for engineering reasons; complete new tunnel driven 85 feet to south.*

[2] *Not used—deep cut made south of old tunnel.*

[3] *Old tunnel completed but not used by Turnpike; cut made to south.*

[4] *Line shift and grade change resulted in shortening from 5365 feet. The old east heading was caved. A new heading was made in a new location.*

When the initial geologic tunnel surveys began in December 1937, the portal areas were being reopened. In the 52 years that had elapsed since the South Penn work stopped, many of the portals were caved shut and were concealed by heavy growths of vegetation, Plates 5B and 15A.

Preliminary reconnaissance surveys were made and followed later by detailed studies which revealed the minute physical features of the rock. The condensed geologic structure sections of the tunnels, which are shown on the strip maps (pls. 21-28), illustrate the type of rock encountered and show the approximate dip of the strata. Details such as these are of infinite value to the tunnel design engineer who must place a lining which will insure absolute safety, and of interest to the contractor who must bid on the excavation.

The type of rock (sandstone, limestone, or shale) assumed importance because of the relative differences in ease of excavation. The dip of the strata, similarly, has a direct bearing on the tunnel design. Steeply dipping strata may be self-supporting, whereas gently dipping to horizontal strata often require support to prevent peeling off of the roof under the influence of gravity. This can be troublesome during the tunnel construction period.

The completion of geological studies in the excavated portions of the old South Penn tunnels was a definite forward step. The next problem involved the undriven sections of the old tunnels about which little was known. Hence, the plan of exploratory diamond drill core-borings in those areas became of prime importance.

Core-boring equipment consists of a rotary drilling machine and hollow-centered drill rods, core-barrel and diamond studded bits. The bits have industrial diamonds set at the drilling edge. When rotated at 200 to 500 revolutions per minute, the bit acts as a circular saw boring a cylindrical hole around a central rock core. The hollow core-barrel, which is the same diameter as the bit, permits the central core of rock to move into the barrel as the bit grinds into the rock. When the core-barrel is filled the rock core is broken free at the bit and removed from the hole. Diamond core drills have an outstanding advantage in the ability to drill a hole at any angle. This proved to be desirable in the tunnel exploratory work where vertical, inclined, and horizontal holes were required.

In the three eastern tunnels, Blue, Kittatinny, and Tuscarora, the rock strata dip very steeply, standing nearly on end. Because of this phenomenon horizontal holes proved most satisfactory. These were drilled from the headings of the old tunnels through the unexcavated areas. In Tuscarora Tunnel the horizontal core boring was 1450 feet long. This is believed to be a record for a horizontal hole.

Vertical core-borings, from the surface of the ground downward, were drilled through the undriven areas of the four westerly tunnels where the rock strata dip only gently. Because of the low dips, vertical borings gave more adequate information than horizontal borings. In Sideling Hill Tunnel nine vertical borings were made, in Rays Hill Tunnel three, in Allegheny Mountain Tunnel five, and in Laurel Hill Tunnel six.

From a study of the recovered rock cores intimate details of the physical features of the strata in the undriven tunnel sections became

available. This information was of infinite value to both the tunnel engineers and contractors. Geologic maps or structure sections on a scale of one inch equals fifty feet were made. Altogether, 14,476 feet of core-drilling was done in the tunnels. Of this, 3,493 feet were horizontal borings, 9,538 feet vertical borings, and 1,445 feet inclined borings.

In the driving of the tunnels, it was recognized that groundwater in the rocks penetrated might have a corrosive effect upon the construction materials used. Pendants of precipitated iron carbonate, found when some of the old South Penn tunnels were reopened, were suggestive of the presence of acid waters. Recognizing the possibility that acid waters might seep into the tunnel and harmfully corrode the steel and concrete construction, a comprehensive study of the character and quality of groundwater was carried on throughout the driving of the tunnels. Details of the groundwater inventory are to be incorporated in the previously mentioned supplementary report.

Corrosive water was encountered in several of the tunnels. In areas where the water might damage the tunnel through corrosive action, the lining was protected by special panels of asphalt-coated steel.

ROAD CONSTRUCTION

Cuts

The maximum grade on the Turnpike is three percent, or a three-foot vertical rise in a linear distance of one hundred feet. In order to maintain this grade in the mountains, many high fills across valleys and many deep cuts through ridges were needed. It was necessary to design the deep cuts carefully, and again the geologist entered the picture.

The design of a cut depends largely on the physical character and structural attitude of the rock and soil to be excavated. For example, a road cut through a sand dune cannot have slopes steeper than the natural stabilized slope, or profile of equilibrium, for loose sand. Any steeper slope will result in sliding of sand onto the roadway. Conversely, a road cut through a homogeneous, flat-lying, massive-bedded sandstone which is not fractured, may safely have nearly vertical slopes. Slopes of cuts on the Turnpike lie between these two extremes. The steepest cut has a ½:1 slope, that is, for every foot of vertical height the slope is laid back one-half a foot horizontally. The average slopes are 1:1—for every foot of vertical height the slope is laid back one foot horizontally.

The largest cut is through Clear Ridge (pl. 17) in Bedford County, about half a mile east of Everett. Original plans called for a tunnel through Clear Ridge, but core-borings and careful study of the bedrock revealed the feasibility of a deep cut. This cut is 2,475 feet long, 380 feet wide at the top and 153 feet in depth at the deepest point. More than 1,130,000 cubic yards, or about 2,480,000 tons of rock were removed by truck during excavation. This amount of material would have required a railroad train of 33,200 cars.

A cut of this depth, if the slopes were unbroken by benches, would expose traffic to the hazard of falling rock. Consequently, two benches, the lower one 23 feet wide and 30 feet above the floor of the cut, and the higher one 15 feet wide and 85 feet above the bottom of the cut, were

constructed. Both of these benches are inclined away from the cut for drainage purposes, and they are accessible for the removal of accumulative debris.

The bedrock in the Clear Ridge cut consists of interbedded sandstone and shale belonging to the Chemung group of strata. Individual beds vary in thickness from approximately 1 to 18 inches. The beds, which trend at right angles to the direction of the Turnpike, are parallel to the linear direction of the ridge and dip 53 degrees to the southeast. Because of the physical characteristics of the rock and the structural attitude of the strata, it is believed the ultimate in safety has been obtained by the plan of cut adopted.

In the Everett Narrows, in Bedford County, the second deepest cut on the Turnpike slices off the nose of Mount Dallas (pl. 14). The location of the road through this gap is a remarkable engineering feat. The existence of the Lincoln Highway on the north side of the Juniata River in the gap precluded the building of the Turnpike on that side. On the south side the problem was similarly complicated. The presence of a railway and a state road, neither of which could be abandoned, made it imperative to cut deeply into the nose of the ridge. The railway is situated between the river and the Turnpike but at a lower level than the latter.

The Mt. Dallas is a side hill cut, approximately 800 feet long. About 250,000 cubic yards or 550,000 tons of rock, the equivalent of 7,325 railway cars of material, was excavated. The cut is more than 125 feet high on the ridge side, and two benches have been made above Turnpike grade. The state road is located in a slot in the lower bench fifty feet above the super-highway, and about 30 feet above this level a second bench has been cut into bedrock. Both benches serve to protect traffic from falling rock.

The strata, locally called ganister, are a white quartz sandstone and white quartzite known as the Tuscarora formation. The quartzite is similar to the quartz sandstone but is more difficult to drill. The trend of the rock is roughly at right angles to the Turnpike, and the beds dip steeply eastward.

Other large cuts are Mt. Joy cut in Westmoreland County, and Negro and Quemahoning cuts in Somerset County.

The rock strata in the ridges through which these cuts were made are either horizontal or very gently dipping. The formations belong in the coal measures, and beds of coal may be observed in both the Negro Mountain and Mt. Joy cuts.

Mt. Joy cut, nearly midway between the Donegal and New Stanton Interchanges, is 97 feet deep, approximately 1200 feet long, and nearly 300 feet wide at the top. Approximately 500,000 cubic yards or 1,100,000 tons of material, equivalent to 14,650 railway cars full of rock were excavated. This cut started down from the top on a 1:1 slope, but when massive sandstone was encountered at a depth of about 15 feet, the slope was steepened to ¾:1.

Negro Mountain cut, six miles east of the Somerset Interchange, bypasses and replaces the old Negro Mountain Tunnel of the South Penn Railroad. It is 67 feet deep, 1500 feet long and has ¾:1 slopes up to 15

feet from the top where they flatten to 1:1. The strata are composed of gently-dipping sandstone, shale, fire clay, and coal and belong in the Conemaugh formation. The coal exposed in the slopes is the Upper Freeport (E) coal which is mined throughout this area.

Quemahoning cut, about 5½ miles west of the Somerset Interchange also by-passes and replaces an old tunnel. This cut is 85 feet deep and 1250 feet long. The strata, which are horizontal, consist of clay shales and sandy shales belonging in the upper part of the Conemaugh formation. The slopes in the cut are similar to those in Negro Mountain.

The foregoing examples are typical of the large cuts on the Turnpike. Insofar as possible the design of these cuts has been made with the idea of maximum safety from the hazard of slides and falling rock.

Coal Mine Excavation

During the excavation and grading of the Turnpike in Somerset and Westmoreland counties an innovation in road construction was initiated. In many sections of these counties the Turnpike right-of-way is underlain by beds of bituminous coal. Locally, mines, both producing and abandoned, occurred near the surface and Turnpike grade. These mines presented a major construction problem because it was known from past experience that roads built over coal mines are frequently damaged by surface subsidence. In order to avoid this danger, an intensive geologic survey of the problem was made where mines existed under the right-of-way. This study included mapping of the underground workings and mapping of the geologic relationships of the coal and bedrock to the roadway. Diamond core-borings were used to explore the mined areas where surface exposures were poor and access to the mines impossible. Subsequent to these surveys two methods of solving the problem were adopted Plates 18 and 19.

In the case of one small limestone mine and a portion of one coal mine "slushing" of the workings was undertaken. The galleries and rooms of the limestone mine were almost entirely within the limits of the right-of-way. Consequently, the entrances to the mine were bratticed (walled up), a small portion of the galleries hand packed with stone, and the balance of the mine "slushed". Ordinarily slushing involves the introduction of fine-grained rock debris, cinders, or crushed slag into the mine to fill the voids. Water is used to transport the slushing material and facilitate its distribution. All workings outside of the area to be slushed are bratticed off with timbers so placed as to drain away the water. Because of the limited extent of the limestone mine, crushed slag was poured dry into the workings where it was distributed by hand labor. In the portion of one coal mine where slushing technique was employed, the crushed slag was blown by compressed air into the walled off galleries and cross-cuts. The entrance was then closed with a dry-packed rock wall.

Generally, the mine-subsidence areas were excavated with power-shovels and scrapers from the surface through the coal beds to solid rock. The coal and fire clay, if present, were removed, and the opened pits backfilled with suitable material and rolled. The excavation commenced

at the outcrop of the coal and continued until the inclination of the strata carried the mine workings and coal beds to a safe depth below Turnpike grade. The limit of excavation was established when the rock overburden was of such physical composition and of sufficient thickness to be self-supporting or to preclude future surface subsidence. Five coal mines were excavated and backfilled according to this plan (pls. 18 and 19). Three of these were in Westmoreland County where the thick Pittsburgh coal bed was involved. Two others were in Somerset County. In one of these the mine was in the Upper Freeport (E) coal bed, and in the other the workings were in the Upper Kittanning (C′) coal bed. In Westmoreland County the excavation of coal mine areas included over 160,000 cubic yards, or 352,000 tons of material, and in Somerset County over 29,000 cubic yards, or 63,800 tons of rock, coal, and earth were moved during these operations. In both of these counties, coal rights on many properties were acquired in order to prevent future mining under the Turnpike right-of-way. Every effort has been made in these areas to protect the Turnpike from any possible settlement over the mines.

Economic Geology

An important function of the geologist during the construction of the Turnpike was to appraise the mineral wealth of lands along the right-of-way. West of the Allegheny Front, coal is the most important mineral resource; to the east non-metallic mineral deposits constitute valuable resources.

Table 1, page 8, indicates for the entire State the mineral resources of each geologic horizon. Pennsylvania is known principally, of course, as a coal-producing state, but its production of oil, gas, limestone, fire clay, glass sand, ganister, slate, and other mineral commodities contributes substantially to its high position among the states as a producer of mineral wealth. Texas, by virtue of its tremendous petroleum production, is the only state to lead Pennsylvania in this field.

The Cambro-Ordovician rocks exposed along the Turnpike include valuable resources of limestone and dolomite, important for cement, flux, concrete, aggregate, road metal, chemical and agricultural lime, etc. These rocks have also been the focus of the residual concentration of iron-manganese and white clay deposits, for the most part sub-marginal in value. The Martinsburg is the geologic horizon of the Pennsylvania slate belt in Northampton County.

The Silurian Tuscarora formation, which is composed of resistant ridge-forming sandstone and quartzite and which makes most of the mountains of the Ridge and Valley province, is the source of ganister, used in the making of silica brick to line industrial furnaces, kilns, and ovens. The Rose Hill (Clinton) beds, also of Silurian age, yielded iron ore to supply many local furnaces during Colonial days. Reference is made in the geologic itinerary to iron ore deposits in the Bedford area.

Rocks of Devonian age yield some brick shale, flagstone, building stone, and other minor mineral products throughout Pennsylvania, but the principal resources of these rocks are oil, gas, and glass sand. The

Oriskany sandstone, seen at Warrior Ridge and elsewhere along the Turnpike, is the source of valuable glass sand. The production is centered around Mapleton, a few miles to the north, in Huntingdon County. In part of the plateau area, where the Oriskany is deeply buried, it is an important source of natural gas. One gas field producing from the Oriskany sand is located on Chestnut Ridge near Uniontown, not far south of the Turnpike. The world-famous Pennsylvania grade oil and natural gas are produced principally from Upper Devonian rocks in western Pennsylvania.

Mineral production from Mississippian rocks is less important than that of the other rock systems represented along the Turnpike. The Loyalhanna sandy limestone has been mined at a number of places in southwestern Pennsylvania. It has been used extensively for ballast and paving blocks. Other products of Mississippian rocks are oil, gas, and building stone.

TABLE 3. *Coal horizons in Westmoreland and Somerset Counties with approximate intervals between coals and commercial importance indicated.*

WASHINGTON	Washington	140
MONONGAHELA	Waynesburg	
		80
	Uniontown	
		145
	Sewickley	
		60
	REDSTONE*	
		75
	PITTSBURGH*	
		160
CONEMAUGH	Lonaconing	
		40
	Barton	
		110
	Harlem	
		125
	Bakerstown	
		100?
	Brush Creek	
		75
	Mahoning	
		45

ALLEGHENY	UPPER FREEPORT* ("E")	
		50
	LOWER FREEPORT* ("D")	
		45
	UPPER KITTANNING* ("C′")	
		40
	Middle Kittanning	
		40
	LOWER KITTANNING* ("B")	
		60
	Clarion ("A′")	
		35
	Brookville (A)	
POTTSVILLE	no workable coals	

* *Commercially important.*

The vast coal resources of the State are contained in the Pennsylvanian System of rocks. There are the Anthracite Fields in the mountains to the north of Harrisburg, the Broad Top Field in Central Pennsylvania, and the extensive Bituminous Fields of the plateau region west of the Allegheny Front. Table 3 shows the coal horizons of the strata traversed by the Turnpike in Somerset and Westmoreland counties. Fire clays, associated with many of the coals, also constitute a valuable product. Limestone and other rock products from Pennsylvanian rocks are also important.

Geologic Itinerary

GENERAL INFORMATION

Maps

To facilitate following the geologic itinerary, a series of strip maps, Plates 21 to 28, inclusive, accompany the guidebook. The maps have been prepared using U. S. Geological Survey topographic maps as a base. The alignment and important features of the Turnpike have been added; geologic information is printed in red. Plate 20 is a generalized geologic cross section from the Cumberland Valley to Irwin. Figure 6 is a small geologic map of the Ridge and Valley section, and Figure 7 shows cross sections through the same area.

Mileage

The present Turnpike is 160 miles in length from Middlesex to Irwin Interchange. Small mileposts are located on the shoulder of the Turnpike at each mile interval, both east- and west-bound. Mileage given in the geologic itinerary refers to these markers. East-bound travelers will find, in addition to the mileposts, that the delineators along the edge carry the mileage in tenths of a mile.

In the following itinerary west-bound mileages read from top to bottom at the left-hand margin of the page; east-bound mileages read from bottom to top in the right-hand margin. In the text *eb* and *wb* refer to east- and west-bound mileage.

At the time this guidebook was submitted to the printer, construction of eastern and western extensions to the Pennsylvania Turnpike was in progress. It was known that the above-mentioned mileposts would be changed, upon completion of the extensions, to conform to new Turnpike distances, but a new marking system had not yet been adopted by the Turnpike Commission.

Safety

For your own safety do not geologize and drive at the same time. When stopping to examine outcrops, park completely off the concrete. Do not walk on the concrete roadway; do not walk across the highway.

East-bound from Irwin turn to page 53.

SECTION 1. CARLISLE—BLUE MOUNTAIN (27.1 miles)

Strip maps 1 and 2 (pls. 21, 22)

The easternmost section of the Turnpike lies wholly within the Cumberland Valley section of the "Great Valley", which is actually a part of the Valley and Ridge physiographic province. In this area, it is underlain by limestones of Cambrian and Ordovician age, shales and sandstones of Ordovician age, and some igneous intrusive basalts of Triassic age, which occur as dikes or locally as sills.

The original valley floor or erosion surface is known as the Harrisburg peneplain, but subsequent uplift has resulted in youthful dissection of this surface. As a result, this ancient erosion surface is today represented by a general accordance of flat-topped hills throughout the valley. The

old peneplain surface stood higher in the section across the valley from Blue Mountain Tunnel than close to the Susquehanna River because the surface was graded to the level of the crosscutting drainage.

Stream grades were very gentle on the Harrisburg peneplain surface, hence stream-meanders were abundant. The Conodoguinet was a typical stream, but with general uplift throughout the area, this old stream became rejuvenated and entrenched its meanders in the surface to a depth of 140 feet. These features are prominently displayed on the topographic maps covering the area. The creek is crossed by the Turnpike several times.

The bed-rock in the valley is strongly folded. One crosses numerous minor anticlines and synclines throughout the eastern 27 miles of the Turnpike. The folding brings to the surface alternating exposures of Cambro-Ordovician limestones and Martinsburg shale of Upper Ordovician age.

On the north, the skyline is dominated by the crest of Blue Mountain. The strata composing this mountain stand nearly vertical. Younger than the rocks in the valley, they are overturned toward the north in the vicinity of Sterretts Gap and in part are broken by thrust-faulting in Blue Mountain Tunnel. The mountain at Doubling Gap has a sharp "S"-shaped pattern which is the surface expression of local "tight" anticlinal and synclinal folds. This reëntrant is almost due north of mileport 16 *wb* or 144 *eb,* but may be seen at many other stations.

The southern skyline is marked by the serrated South Mountain ridges. South Mountain is underlain by volcanic rocks which have been designated as pre-Cambrian, and are much older than any of the rocks exposed along the Turnpike. The mountain, a broad anticlinorium flanked by Cambrian quartzites, is a northern continuation of the Blue Ridge Mountains of Virginia.

Cumberland Valley is noted chiefly for its agricultural wealth, but it is not lacking in mineral wealth. A number of scattered limestone quarries operate throughout the area. On the flanks of South Mountain an iron industry flourished in the early eighteen hundreds, utilizing residual iron-manganese ores, appreciable reserves of which remain today. Reserves of white and manganiferous clays have also been worked on South Mountain.

Mileage West-bound		Mileage East-bound
0.0	Leaving U. S. Route 11 (See strip map no. 1, pl. 21).	160.0
0.4	Route 11 passes under the Turnpike at Middlesex and the eastern terminus. MARTINSBURG SHALE. To the south of the highway, across the Cumberland Valley we see the South Mountain, the core of which is volcanic rocks.	159.6
1.4	MARTINSBURG SHALE, platy, calcareous, grading into black siliceous shale. Approximate CONTACT between the CAMBRO-ORDOVICIAN limestones and the MARTINSBURG. Turnpike travelling at the level of the *Harrisburg peneplain* (pl. 5A).	158.6

Mileage West-bound		Mileage East-bound
2.5	*Carlisle Interchange.* Ticket booth. Route 34 passes under the Turnpike. *Carlisle,* historic frontier town, was founded in 1751 as the seat of Cumberland County. It supplied a contingent for the first Continental Army in 1775. In 1794, the march against the Whiskey Rebels began at Carlisle. Carlisle Barracks, just north of the town, is the second oldest army post in the United States. A powder magazine built here by Hessian prisoners in 1777 still survives. The post was burned by Confederates July 1, 1863, rebuilt to serve as Indian School, 1878-1918, and Army Medical Field Service School from 1920. Carlisle is the site of Dickinson College, founded in 1783. Molly Pitcher, heroine of Monmouth, was a resident of Carlisle.	157.5
3.0-3.2	CAMBRO-ORDOVICIAN limestone, dark gray, somewhat argillaceous, solution pits on bedding planes. Exposed in long cut. Strike N82°W, dip 62°N.E.	156.8-157.0
5.25	CAMBRO-ORDOVICIAN limestone and an old lime kiln.	154.75
5.45	CAMBRO-ORDOVICIAN limestone, crystalline, dove-gray, porous, platy. Strike N43°E, dip 27°SE.	154.55
5.85	West boundary, Carlisle Quad.; east boundary, Newville Quad.	154.15
7.58	CAMBRO-ORDOVICIAN limestone, bluish-black, platy to medium-bedded. Strike N28°S, dip 18°SE.	152.42
7.8	*Plainfield Gas Station (eb)* J. E. Diller, Geologist of U. S. Geological Survey, 1883-1928, is buried in cemetery to south of highway.	152.2
9.25	CAMBRO-ORDOVICIAN limestone, at bridge over the Turnpike. Impure, blue-gray limestone, some lensing, strongly fractured and cut by calcite veins. Platy limonite developed in residuum. Strike N61°E, dip 40°SE.	150.75
10.48	CAMBRO-ORDOVICIAN limestone, blue-gray, dense, crystalline. Strike N68°E, dip 47°NW.	149.52
10.95	CAMBRO-ORDOVICIAN limestone, weathers light-gray, grainy structure on weathered surface. Strike N23°W, dip 21°NE.	149.05
11.7	ORDOVICIAN (TRENTON?) limestone. Dense, blue, highly fossiliferous. Strike N60°E, dip 71°SE.	148.3
11.75	Bridge over the Turnpike. The CONTACT between the MARTINSBURG and the CAMBRO-ORDOVICIAN (TRENTON) limestones occurs just west of this bridge.	148.25
11.85	*Conodoguinet Creek* bridge crossing. MARTINSBURG shale.	148.15

Mileage West-bound		Mileage East-bound
12.4	Martinsburg shale, black, siliceous, pencil fragments. Used extensively for shoulder material. Strike N65°E, dip 79°NW.	147.6
12.8	*Newville Maintenance Building*	147.2
15.0	Martinsburg shale in long deep cut. Black siliceous shale, and hard, massive sandstone interbeds. Exposed surfaces on the sandstone show "mud-flows" contemporaneous with deposition, north side of road. Strike N52°E, dip 82°SE.	145.0
16.0	View of *Doubling Gap* to north (pl. 6A).	144.0
17.3	Martinsburg shale in long cut, black, siliceous. Strike N53°E, dip 70°SE.	142.7
18.45	Martinsburg shale, siliceous with occasional sandy beds. Strike N56°E, dip 78°NW.	141.55
19.25	West boundary, Newville Quad.; east boundary, Shippensburg Quad.	140.75
19.65	Martinsburg shale in cut and in the banks of the underpass beneath and north of the Turnpike. Showing numerous minor folds, the shale is fissile and in part arenaceous. Strike N65°E, dip 73°NW.	140.35
19.8-24.0	Throughout these miles numerous low cuts show outcroppings of weathered Martinsburg shale. At *wb* 21.8 (*eb* 138.2) miles, view *Doubling Gap Valley* to northeast; note winding crest of ridge.	136.0-140.2
24.5	*Blue Mountain Gas Station (wb)*	135.5
25.7	*Blue Mountain Interchange* connects with State Route 944. Martinsburg, black shale.	134.3

The area to the south in Franklin County is rich in Colonial and Civil War history.

Following Braddock's defeat in 1755, a number of forts were built in the Cumberland Valley as a refuge against Indian attack. In this area the following have been commemorated by historical workers: Fort Chambers, Fort Davis, Fort McCord, Fort Loudon, Fort McDowell, Fort Weddell, and Rev. Steele's Fort. Fort McDowell, used by Provincial authorities until the building of Fort Loudon in 1756, was the starting point of the road westward which was constructed by Colonel Burd in 1755.

In June 1863 Confederate troops under General Robert E. Lee invaded the Cumberland Valley as far north as Carlisle, from which point they withdrew to cross South Mountain at Cashtown and engage the Union Army at Gettysburg. General John McCausland's Confederate Cavalry penetrated the

Mileage West-bound		Mileage East-bound
	area again the following year, burning Chambersburg in reprisal for the ruin of the Shenandoah Valley by General Hunter.	
27.5	*East Portal Blue Mountain Tunnel* (pls. 3C and 5B). MARTINSBURG, black, siliceous, pencil shale. Strike N45°E, dip 38°NW.	132.5
28.35	*West Portal Blue Mountain Tunnel.* ROSE HILL (CLINTON) weathered shales, extremely fossiliferous in the cut above the portal building. Strike N46°E, dip 55°NW.	131.65
28.5	*East Portal Kittatinny Tunnel,* Plate 15, and *Gunter Valley.* At this portal the BLOOMSBURG red shale is faulted into position against the ROSE HILL formation. The structure through Blue and Kittatinny tunnels being synclinal, the development of the valley may be attributed in part to faulting and to the work of Trout Run parallel to the axis of the syncline.	131.5
29.4	*West Portal Kittatinny Tunnel.* MARTINSBURG, black siliceous shale (pl. 9B). Strike N55°E, dip 68° to 90°SE. *Amberson Valley* to the north.	130.6

East-bound travelers turn to page 19 for a general description of Section 1: Carlisle—Blue Mountain.

SECTION 2. BLUE MOUNTAIN—ALLEGHENY MOUNTAIN (76.15 miles)

Strip maps 2, 3, 4, 5, and 6 (pls. 22, 23, 24, 25, and 26)

This stretch of the Turnpike passes through the Ridge and Valley physiographic province. It is so named because differential erosion of the intensely folded and crumpled bed-rock has resulted in a surface featured by parallel, sharp-crested ridges and narrow, deep valleys. The general concordance of the elevations of these ridge crests has been interpreted as an expression of an erosion surface known as the Schooley Peneplain. Much has been written pertaining to this ancient surface, and ingenious techniques have been developed for the purpose of postulating its extent, subsequent warpings, and ultimate dissection.

The bed-rock exposed includes strata dating from the Cambrian to the Pennsylvanian Coal Measures (figs. 6 and 7). The latter occur as an outlier in the Broad Top Syncline, remote from the general area of their outcrop west of the Allegheny Front. The Broad Top Coal Field is located in the area between Sideling and Rays Hill, but the Turnpike crosses near the southern extremity of the structure, hence the youngest strata seen along the road are Pocono and Mauch Chunk.

The oldest rocks traversed by the Turnpike are found in the area between Bedford and Everett. The subdivision of the Cambro-Ordovician rocks in this area is the result of work by Professor Frank M. Swartz, Pennsylvania State College, an authority on the Lower Paleozoic of Central Pennsylvania. In Path Valley, between Kittatinny and Tusca-

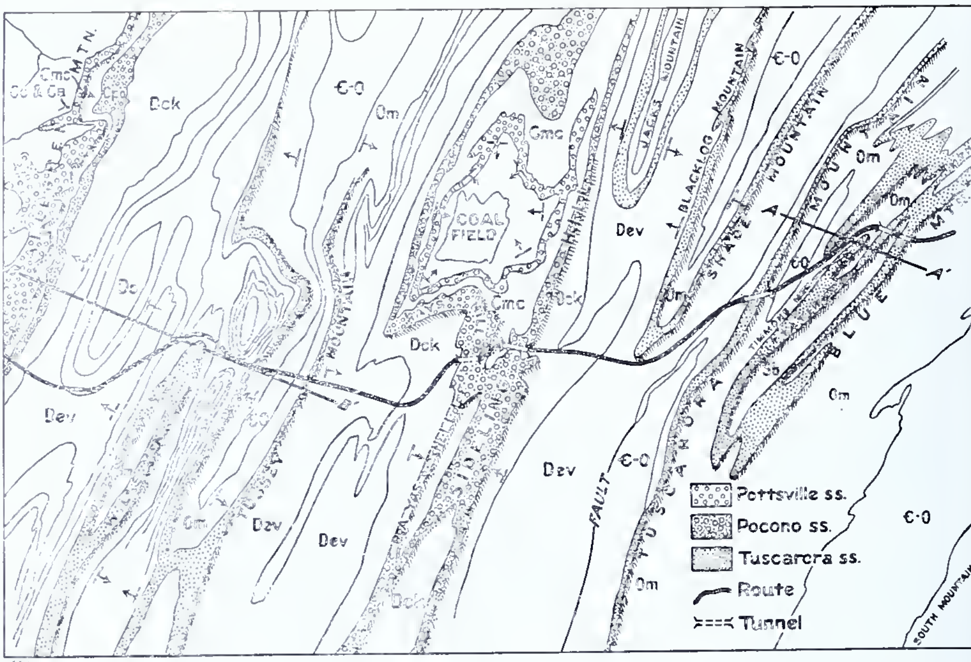

FIGURE 6. Generalized geologic map of the Ridge and Valley section of the Turnpike route.

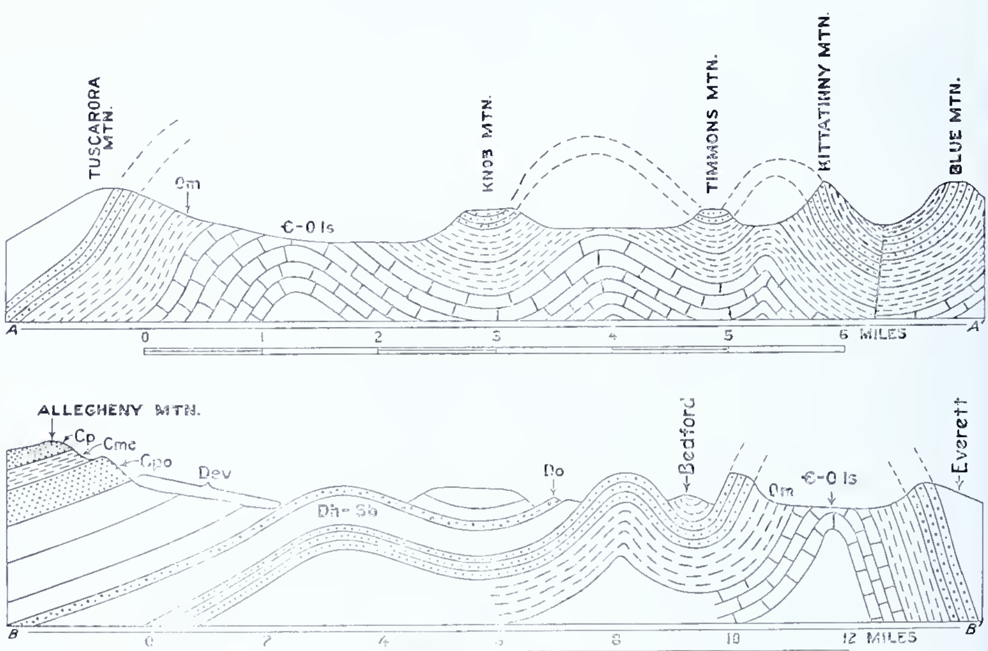

FIGURE 7. Diagrammatic geologic cross section of the area shown in Figure 5.

rora Mountain tunnels, the underlying rocks consist of undifferentiated limestones of the upper portion of the Cambro-Ordovician sequence, and the overlying Martinsburg shale.

Folding of the strata in this section of the Turnpike has been associated with faulting. Some of the faults are low-angle thrusts (as in Blue Moun-

tain), but others are normal strike-slip, tear, and transverse faults. Great Cove Fault, crossed by the Turnpike near Burnt Cabins, in Fulton County, apparently brings Upper Devonian into contact with Middle Silurian. Another major fault is the Friends Cove overthrust near the axis of the Friends Cove anticline in Bedford County. A more comprehensive study of the faulting than possible in this report is desirable.

The economic resources of the area are chiefly silica sand from the Tuscarora and Oriskany formations north and south of Bedford and Everett, limestone for road metal and other purposes, coal in the Broad Top Field, low-grade iron ores, and natural gas, possibilities of which are being actively investigated today. The iron ores assumed some importance in Colonial days and during the Civil War, but promise no serious potentiality for the future until high-grade deposits in other parts of the United States are exhausted.

Mileage West-bound		Mileage East-bound
29.9	MARTINSBURG shale on the northeast end of *Timmons Mountain,* a synclinal spur of Kittatinny Mountain which noses out just south of the Turnpike. The shale is splintery, siliceous, black, and contains hard sandstone interbeds. Strike N60°E, dip 42°SE.	130.1
30.5	Note cove on south, minor plunging anticline	129.5
30.8	North end of *Timmons Mountain,* a syncline plunging to the south with crest of TUSCARORA and flanks of MARTINSBURG.	129.2
32.2	MARTINSBURG shale, strongly weathered with a veneering of stream gravels, along valley of West Branch of Conococheague Creek.	127.8
33.2	Gravel deposit, stream terrace.	126.8
33.85	Gravel deposit, stream terrace.	126.15
34.25	West boundary, Shippensburg Quad.; east boundary, Orbisonia Quad.	125.75
34.9	Nose of synclinal *Knob Mountain* on north (pl. 6B). The crest of the mountain is TUSCARORA sandstone, the underlying MARTINSBURG shale forming the lower part of the nose of the syncline.	125.1
35.2	MARTINSBURG shale, as above without sandstone interbeds.	124.8
35.4	MARTINSBURG shale, in cut. Fissile, black, siliceous shale with interbedded sandstone units occurring near the base. The sandstone is cross-bedded. Strike N25°E, dip 42°SE.	124.6
36.0	CAMBRO-ORDOVICIAN limestone (TRENTON?), platy, very fossiliferous on the north side of the road at the west end of the cut. On the south side of the road, MARTINSBURG black shale outcrops. CON-	124.0

Mileage West-bound | Mileage East-bound

tact with the Martinsburg. Strike N37°E, dip 46°SE. Approximately on the line of strike to the north, one mile south of Spring Run, there is a large quarry opened in these limestones. The strata at the top of the series exposed are very fossiliferous (Trenton?). Strike N41°E, dip 43°SE.

37.1 "Rosebud" concretions in open fields and borrow pit, 50 feet north of the Turnpike near the country road underpass. Note large blocks of light-gray, dense, massive limestone weathering almost white. 122.9

37.4 Cambro-Ordovician limestone, light-gray, thick-bedded. Strike N55°E, dip 26°SE, Plate 6C. 122.6

38.4 *Willow Hill Interchange.* Cambro-Ordovician limestones. The Turnpike is here aligned with the crest and axis of an anticline. At the ticket booth to the southeast, the strata strike N52°E and dip 27°SE. (These beds are replete with "Rosebud" siliceous concretions varying in size from marbles to basket-balls.) In the interchange underpass, northwest side of the Turnpike, the strata strike N45°E, and dip 46°NW. 121.6

39.1 *Path Valley Gas Station (eb)* 120.9

39.65 *East Portal Tuscarora Tunnel.* Black, siliceous Martinsburg shale, thin-bedded. Strike N33°E, dip 64°SE. 120.35

40.75 *West Portal Tuscarora Tunnel,* Plate 10B. Wills Creek red and yellowish-green, soft shales crop in the approach cut to the tunnel. Dip 78°W. 119.25

41.0 *Burnt Cabins Maintenance Building.* The cabins of early settlers in this vicinity were burned by Provincial forces in 1750 to satisfy Indian protests against white trespassers on their lands. 119.0

41.1 Tonoloway (ribbon) limestone, exposed under the footings of the bridge which carries the Turnpike over a township road. 118.9

41.8 Tonoloway (ribbon) limestone, gray, thin-bedded. 118.2

42.0-42.8 Wills Creek, interbedded red and greenish-yellow, soft shales (pl. 7A). 117.2 118.0

42.8 Keefer quartzite resting on Rose Hill (Clinton) and underlying the McKenzie. This exposure is at the eastern end of the structure carrying the Turnpike over the Fannettsburg-Burnt Cabins Road. The Keefer is also exposed at the western end of this structure. 117.2-

Mileage West-bound		Mileage East-bound
	The Rose Hill is best exposed in the cut beneath and northwest of the bridge where it is fossiliferous. The weathered shales overlying the Keefer probably represent the McKenzie; they are in part faulted out. They are fossiliferous. Strike N55°E, dip 57°SE. Keefer appears three times in the next one-half mile west-bound.	
43.3	Keefer quartzite, cream-colored, and the fossiliferous Rose Hill shale and sandstone. These strata are locally, complexly folded and faulted. Strike E-W, dip 44°N.	116.7
43.4	Wills Creek, interbedded red shale and greenish-yellow shale with ripple-marked surfaces. Strike N83°E, dip 57°NW. The village of *Burnt Cabins* immediately north of the highway.	116.6
43.4-44.0	Great Cove Fault, sometimes called the Fulton County Fault. There is a concealed interval in this area, but the presence of a fault is inescapable. The first strata west of the concealed section are Upper Devonian; those adjacent to the east are Silurian. Studies made in the valley north of Burnt Cabins, and Pennsylvania Second Geological Survey reports, all substantiate strong faulting here. This fault is one of the greatest known to date along the line of the Turnpike.	116.0-116.6
44.9	Brallier (Upper Portage Group) shale, in part arenaceous, green, fossiliferous.	115.1
45.1	Brallier shale with thin sandstone interbeds. Dark green, occasional fossils. Strike N27°E, dip 69°SE.	114.9
45.4	*Gobblers Knob* (1,954 feet) on north, point of anticline rising to north in Tuscarora (Upper Medina) sandstone (pl. 7B).	114.6
46.0	Brallier shale.	114.0
46.1	Upper Portage (Brallier) sandstone, argillaceous, mottled red and green. Strike N18°E, dip 48°SE.	113.9
46.6	Burket, black, thin-bedded, arenaceous shale. *Buchiola, Manticoceras, etc.* Strike N15°E, dip 27°SE.	113.4
46.9	Local anticline with residual soil bounding a strongly shattered, bluish-gray limestone which is thought to be Tully. Occasional fragmentary fossils are found. The limestone on the east side of the road strike N70°E and dip 41°SE; the limestone on the west side of the road strike N34°E and dip 28°NW. The strong fracturing and development of clay suggest that this anticline of Tully(?) may in part be faulted into position.	113.1

Mileage West-bound		Mileage East-bound
47.4-47.65	*Fort Littleton Interchange*—connects with U. S. Route 522. Harrell shales, black, fissile, thin-bedded. Barren. Strike N30°E, dip 26°SE (pl. 11A). These shales are strongly jointed, the fractures striking N85°E and standing vertical. *Scrub Ridge* (1,600-1,850) on southeast forms west flank on an anticlinal mountain which plunges toward Turnpike north of Sidney's Knob. *Fort Littleton* was built in 1756 during the French and Indian War at the order of Governor Morris and garrisoned by 75 men. It was one of a chain of forts to protect settlers and roads to the Ohio Country and was abandoned after 1763.	112.35-112.6
48.1-48.3	Clay, orange and bluish-gray. It is suggested that a minor fault passes through this area. In the same cut, calcareous shale and a strongly slickensided blue limestone (both fossiliferous) are found. The anticlinal structure is plainly seen, the easterly beds strike N67°E and dip 49°SE, the westerly strata striking N25°W and dipping 32°SW. The limestone is believed to be Tully, the intervening shale, Upper Hamilton (Moscow), with an underlying slightly conglomeratic Hamilton sandstone.	111.7-111.9
48.8	Portage shale, green, soft, interbedded with thin-bedded argillaceous sandstone. Strike N31°E, dip 19°SE.	111.2
49.6-50.0	Portage shales and interbedded, thin sandstone. Strike N36°E, dip 37°SE. A few hundred yards north across the Hustontown Road, the Helderberg limestones are quarried, and Oriskany beds outcrop. Known faults occur in this area, but locally may decrease in magnitude so that the Portage is scarcely affected at this point on the Turnpike.	110.0-110.4
49.9	West boundary, Orbisonia Quad.; east boundary, Broad Top Quad.	110.1
50.15-50.25	Portage shales consisting of greenish shale and interbedded, slabby sandstone. Strike N23°E, dip 87°NW. *"Spirifer" mucronatus var. posterus, Chonetes, etc.*	109.75-109.85
50.8	Portage shales. Olive-drab shale with occasional interbeds of grayish-green sandstone. Much of the shale breaks down into pencil fragments. Fossils. On the north side of the road, faulting complicates the structure. There is a fault on the west limb of a small syncline. The strata dip east; west of the fault the dip is 16°E and east of the fault 50°E. The east limb of the syncline is seen striking N15°E and dipping 26°NW.	109.2

Mileage West-bound		Mileage East-bound
51.6	Bridge over the Turnpike. Cut in CHEMUNG, interbedded red sandstone and greenish-gray shale.	108.4
51.7	Approximate CONTACT CATSKILL facies with CHEMUNG (pl. 13A). Fossils at 51.65 *wb* (108.35 *eb*). Interbedded green shale, red shale, gray-green sandstones, and "mud-chip" beds. A one-foot conglomeratic bed is also present.	108.3
52.9-53.2	CATSKILL facies, consisting of soft red and arenaceous shales with interbedded sandstone. Strike N57°E, dip 34°NW.	106.8-107.1
55.5	*Cove Valley Gas Station (wb).* Note high-terrace gravels on red shales near viaduct.	104.5
55.9	CATSKILL facies. Red shale and sandstone. Contact with POCONO concealed to the west. In this cut the strata are strongly fractured and folded. Strike N20°E, dip 11°SE.	104.1
56.45	*East Portal Sideling Hill Tunnel,* Plate 13B. This is the longest tunnel on the Turnpike (6,632 feet). The entire tunnel is driven through the POCONO formation. The sandstone, which dips west at a low angle into the BROAD TOP SYNCLINE, is complicated by faulting.	103.55
57.7	*West Portal Sideling Hill Tunnel* (pl. 8A). Approach cut and tunnel in the POCONO sandstones and shale. Minor folding and faulting cause varying strikes and dips. In the approach cut one strike is N42°E, and dips vary from 16°NW to 26°SW.	102.3
58.4	Rim of BROAD TOP COAL FIELD seen in distance to north.	101.6
59.3	POCONO, platy sandstone, brought to the surface in a minor anticline. MAUCH CHUNK crops both east and west. Strike E-W, dip 26°N.	100.7
61.0	MAUCH CHUNK red shales.	99.0
61.6	*East Portal Rays Hill Tunnel* (length 3,396 feet). MAUCH CHUNK is exposed at portal. Red and soft yellow and red shale, thin-bedded. Strike N16°E, dip 34°SE. In this tunnel the POCONO sandstone rises sharply to the west. The MAUCH CHUNK is exposed at the east portal; the tunnel is driven mostly through POCONO, and the underlying CATSKILL is exposed at the west portal. The area between *Rays* and *Sideling Hill* is in a gentle syncline, complicated by a minor anticline that brings the POCONO to the surface approximately midway between the tunnels. To the north, in this	98.4

Mileage West-bound		Mileage East-bound
	basin, progressively younger strata occur so that the productive coal measures are found, in this, the Broad Top Coal Field.	
62.25	*West Portal Rays Hill Tunnel*, Plates 3A, 8A and 12. Catskill facies. Soft, earthy, and arenaceous red shale. Strike N16°E, dip 38°SE.	97.75
63.6	South boundary, Broad Top Quad.; north boundary, Needmore Quad.	96.4
63.65	Crossing the Lincoln Highway, Route 30.	96.35
64.2	*Breezewood Interchange* to U. S. Route 30.	95.8
65.1	West boundary, Needmore Quad.; east boundary, Clearville Quad.	94.9
65.6	Catskill facies, red sandstones and shale. Strike N5°E, dip 10°E.	94.4
67.5	Catskill facies, sandstone and red shale. Strike N37°E, dip 7°W.	92.5
69.4-69.6	Catskill facies—bridge over the Turnpike at *wb* 69.5 (*eb* 90.5) miles, near the axis of a minor syncline, the east limb dipping 24°NW with local steepening to 64°NW, and the west limb dipping 38°NE, flattening to 10°NE.	90.4-90.6
70.0	Catskill facies, red sandstones and shales in all cuts from Rays Hill westward to Clear Ridge. Considerable folding is evident in many cuts, hence numerous minor synclines and anticlines can be mapped in this area. At *wb* 69.8 (*eb* 90.2), the strata dip 50°NE. At *wb* 70.0 (*eb* 90.0) the strata dip westward 10° to 45°.	90.0
70.5-70.9	*Clear Ridge Cut*, Plate 17. This is the deepest highway cut in the eastern United States, being 153 feet deep and 2,475 feet long. Benches collect rock falls from higher parts of the walls to protect traffic. The strata strike across the Turnpike at this place, and there has been no trouble with slides such as those in the Catskill (New Baltimore slide) just east of the Allegheny Front where strata dip toward the Turnpike. In *Clear Ridge Cut* the strike is N32°E, dip 53°SE. The cut continuously exposes 1,800 to 1,900 feet of Upper Devonian, Chemung shale and sandstone with some Catskill shaly red sandstone at the east end. The Chemung beds at the Allegheny Front are about 2,000 feet thick, with purplish shales in the higher portion; they are marine and contain the *Spirifer disjunctus* fauna with *Dal-*	89.1-89.5

Mileage West-bound		Mileage East-bound
	manella tioga in the lower quarter. At Clear Ridge cut, the purplish tongues of the higher CHEMUNG become more prominent, red, and CATSKILL-like and give witness to the eastward change taking place in the CHEMUNG as it transforms into the red continental CATSKILL facies; before reaching Harrisburg, this change from the westerly, gray-brown, brachiopod-rich CHEMUNG to red continental CATSKILL is completed and denotes approach to the old land region from which these sands and clays were worn by Upper Devonian river systems. From the hilltop there is a fine view of the regional structure. To the west, wooded hills in *Friends Cove* underlain by the UPPER CAMBRIAN GATESBURG formation can be seen through *Aliquippa Water Gap* in *Tussey Mountain,* where basal SILURIAN TUSCARORA sandstone plunges below ground to continue beneath the route to *Tuscarora Tunnel* 30 miles to the east. To the northeast is visible a salient of *Rays Hill* at the western "Fish-Tail" prong of the POCONO rim of the BROAD TOP SYNCLINORIUM. The deeper syncline of the eastern prong, which brings the POCONO below ground along our route, will be crossed 8 to 12 miles east of Clear Ridge between Rays Hill and Sideling Hill tunnels.	
71.0	North boundary, Clearville Quad.; south boundary, Everett Quad.	89.0
71.6	CHEMUNG in a cut 25 to 30′ deep (pl. 8C). Green shales and interbedded chocolate-red sandstone and shale. *Pterinea chemungensis.* Dip 42°SE.	88.4
71.7-71.9	PORTAGE shales. Soft olive-drab shale, barren. TULLY and HARRELL beds are concealed in the valley to the west. In this cut, the strata are folded into a syncline, the east limb dipping 47°W and its west limb dipping 44°E. There is an overhead bridge in the middle of the cut at *wb* 71.8 (*eb* 88.2) miles.	88.1-88.3
72.2	HAMILTON group. In a 40′ deep cut, brownish weathering gray sandstones, thin-bedded except for a massive unit near the center of the cut, are overlain by HAMILTON shales in the eastern end of the cut. Strike N26°E, dip 48°SE. Locally, these beds are very fossiliferous; large *"Spirifer's", Chonetes, and Tropidoleptus.*	87.8
72.5-72.6	*Warrior Ridge.* LOWER DEVONIAN strata in deep cut. The sequence of the strata in this cut is:	87.4-87.5

EAST

—— NEEDMORE (ONONDAGA) black, fissile shale.
ORISKANY group.

Mileage West-bound		Mileage East-bound
	114′ RIDGELEY sandstone, fossiliferous.	
	76′ SHRIVER chert, weathered, fragmentary.	
	HELDERBERG formation.	
	75′ NEW SCOTLAND chert, weathered, fragmentary. No fossils found.	
	15′ KEYSER limestone, crystalline, very fossiliferous limestone.	
	WEST	
	The strata strike N36°E, dip 41°SE.	
	Across the Juniata River, from the town of *Everett* north, continuous exposures of ORISKANY occur. It is extensively quarried at Tatesville, 3 miles north of *Everett*, by the Pittsburgh Silica Sand Company.	
72.8	*Everett Maintenance Building* and shops for the Pennsylvania Turnpike. Site of *Everett-Saxton iron works*. Note slag piles. *Everett* was former iron town.	87.2
73.1	ROSE HILL (CLINTON), covered but under the houses on the south side of the road there exists a filled shaft used in Colonial days for mining the "Clinton" iron ore.	86.9
73.4-73.75	*Aliquippa Gap-Tussey Mountain*, the nose of which at this point is called *Mt. Dallas*, Plate 14. In this gap a sequence of strata is exposed from the TUSCARORA quartzite (east) through the BALD EAGLE (OSWEGO) on the west, same as in the *Bedford Narrows*, but with the sequence reversed. The strata strike N22°E and the dip varies from 44° to 64°SE. Some faulting and shearing is apparent. The TUSCARORA white quartz sandstone and quartzite (ganister) contain *Arthrophycus (worm trails)*. At *wb* 73.7 (*eb* 86.3), the BALD EAGLE, an easily recognizable rusty speckled sandstone, is strongly shattered and faulted. Near the west end of the cut, the CONTACT between the sandy UPPER MARTINSBURG and the BALD EAGLE may be seen *wb* 73.8 (*eb* 86.2). All contacts are observed although not always clear.	86.25-86.6
75.0-75.1	*New Enterprise limestone plant* (north) and quarry (south) of the Turnpike. Quarry is in CHAZYAN-BLACK RIVER (MIDDLE ORDOVICIAN) limestone. Strike N27°E, dip 43°SE.	84.9-85.0
75.1-75.95	LOWER ORDOVICIAN BEEKMANTOWN dolomites (pl. 10A), largely whitish weathering and of BELLEFONTE type. The AXEMANN limestone, which separates the BELLEFONTE dolomite above from NITTANY dolomite below in the State College region, tends to disappear southward rendering distinction of two	84.05-84.9

dolomites less satisfactory. Strike N31°E, dip 33°SE.

76.3 Fields south (to right) of the Turnpike bear chert fragments with much siliceous oolite of type characteristic of MINES dolomite, 250 feet, at top of GATESBURG formation. The contact between the MINES and GATESBURG occurs about at the woods line at the west edge of the field. 83.7

76.4-76.8 Additional cuts expose GATESBURG sandy dolomite, with ORE HILL limestone member at about *wb* 76.8 (*eb* 83.2). 83.2-83.6

76.9-77.0 Beds below middle of the UPPER CAMBRIAN GATESBURG sandy dolomite are exposed in a cut on the south side of the highway. The GATESBURG is about 1,600 feet thick; it contains interlayers of sandy dolomite and quartz sandstone, the sand forming about 10 per cent of the mass, and weathers to a thick mantle of loose sandy soil. 83.0-83.1

The Middle part of the GATESBURG contains the 50- to 100-foot ORE HILL limestone, characterized by trilobites found near Chambersburg below the middle of the CONOCOCHEAGUE limestone. It is reasonably clear that the sandy GATESBURG of central Pennsylvania grades southeastwards into the somewhat silty CONOCOCHEAGUE limestone, giving evidence that the GATESBURG sands were transported to central Pennsylvania from the north and northwest. These sands are thus not expected to disappear on the north and northwest by change to finer sediments.

77.3 Scattered crops of UPPER CAMBRIAN WARRIOR limestone dipping about 30°SE. Cryptozoan heads provide an interesting means of showing that these beds are not overturned. The WARRIOR strata by dip appear to overlie the BELLEFONTE (BEEKMANTOWN) of the last cut to the west; their trilobites show that they are early UPPER CAMBRIAN in age; they belong about 4,000 feet below the BEEKMANTOWN and have been carried to their present position by the FRIEND'S COVE OVERTHRUST. The thrust plane probably forms a rather low angle to the bedding, and, if so, the actual slip may have been of the order of several miles. This fault was first identified by James Wilson. 82.7

77.45-77.55 Long cut in light-weathering BELLEFONTE dolomite of LOWER ORDOVICIAN BEEKMANTOWN group. The beds dip about 45°SE and lie in the southeastern limb of the anticlinal fold. 82.45-82.55

Mileage West-bound		Mileage East-bound
77.8	*Juniata River Crossing.* Contact of the Martinsburg with the Upper Ordovician limestones was observed in the coreborings for the foundations of this bridge, but is no longer exposed. The Cambro-Ordovician limestone does not reappear to the west until brought to the surface on the Cincinnati Arch.	82.2
78.05-78.4	*Bedford Narrows* where Raystown Branch of Juniata River cuts through *Evitts Mountain.* View of cut along Turnpike from south side of gap. The highway cut is 2,200 feet long and exposes upended Early Silurian and Late Ordovician sandstones in the western limb of the Friend's Cove anticline or southern component of the great Nittany Valley arch. Stratigraphically the beds dip to the northwest, but range from vertical to overturned where objectively the dip is as low as 40 degrees southeast. The strata are cut by numerous faults of small throw. Some are subvertical faults with strikes nearly paralleling the Turnpike; the cuts expose large faces of one or two faults of this type. Overthrust faults dipping to the west and thinning the sequence are numerous; the movement on the individual fault is small, but the total effect may amount to reduction in apparent thickness of between 50 and 100 feet. At the east end of the cut, fault duplication has placed out of stratigraphic order 60 feet of interbedded red and green shaly sandstones.	81.6-81.95

The section exposed is as follows in descending order, according to measurements of F. M. Swartz assisted by Doris Bye:

Bedford Narrows Section

LOWER SILURIAN:

Tuscarora Sandstone: thick bedded, resistant, white silica-cemented quartz sandstone or quartzite, making main ridge of Evitts Mountain. Used as ganister rock for silica brick in central Pennsylvania, the Tuscarora extends westward and northwestward into the gas-producing White Medina ("Clinton" Sand of Ohio), represented by the Whirlpool sandstone in Niagara Gorge. *Total thickness 400+ feet. Exposed in west end of cut* . . . . *165 feet*

UPPER ORDOVICIAN

Juniata Red Beds:

Upper reddish quartzitic member: dark red quartzitic sandstone, with thin partings of red silty shale increasing below . . . . *60 feet*

Red siltstone member: red siltstone or mudstone and interbedded red sandstone . . . . *610 feet*

Lower sandstone member: thick bedded red medium-grained

sandstone and some interbedded red mudstone; some minor interbeds of greenish sandstone in lower part ...... *380 feet*
The Juniata correlates with the Queenston of Rochester and Niagara gorges
Total thickness Juniata red beds .... *1,050 feet*

BALD EAGLE SANDSTONE: *(intertonguing with Juniata facies)*
Ridge making member: thick bedded, cross-bedded, greenish and much interbedded reddish sandstone or graywacke, with a few thin partings of gray or reddish shale; shale chips are common; a few ¼- to ½-inch pebbles of milky quartz occur in three thin lenses. These beds make subsidiary ridge of the mountain .... *215 feet*
Lower shaly member: interbedded greenish and reddish sandstone or graywacke and greenish and reddish silty mudstone that forms about a third of mass .... *320 feet*
Total thickness of Bald Eagle sandstone .... *535 feet*

REEDSVILLE SHALE:
Upper sandy member containing *Orthorhyncula stevonsoni* fauna: carbonate-bearing greenish siltstone and some interbedded sandstone .... *47 feet*
(Bald Eagle red and green shaly sandstone duplicated by faulting at east end of cut; about 60 feet.)

78.5 Viaduct over *Dunning Creek* at its junction with the Juniata. Foundations for this structure placed on ROSE HILL (CLINTON) strata which are no longer visible. 81.5

79.2 ORISKANY (RIDGELEY sandstone). Yellowish-brown sandstone and chert. *Platyceras and Spirifer arenosus* common. This is the east limb of a shallow syncline. Dips to west. 80.8

79.4 NEEDMORE shale (ONONDAGA). Strongly weathered black shale. 80.6

79.7 *Turnpike Midway,* Plate 3A. Service stations *wb* and *eb;* pedestrian tunnel leads to restaurant. 80.3

80.0-80.1 ORISKANY (RIDGELEY sandstone), yellowish-brown, strongly weathered, breaks down into a sand. Occasional fossils. This is the west limb of a shallow syncline. 79.9-80.0

80.25 West boundary, Everett Quad.; east boundary, Bedford Quad. 79.75

80.4 Bridge over the Turnpike. ORISKANY, decomposed, is exposed. 79.6

80.55-80.6 KEYSER limestone. Massive, and in part cherty limestone; prominent *Stromatoporoid* bed. Cherty beds rest on top of the KEYSER, but no COEYMANS or NEW SCOTLAND fossils have been reported. Strike N11°E, dip 21°SE. 79.4-79.45

80.85 TONOLOWAY limestone (north) in 60′ cut. The KEYSER limestone occurs on top of this "ribbon" shaly limestone. 79.15

Mileage West-bound		Mileage East-bound
81.35	TONOLOWAY limestone, east of underpass. Many ostracoda. Strike N10°E, dip 23°SE. *Wills Mountain* rises to southwest, culminating in *Kinton Knob* (2,642 feet).	78.65
81.4	Underpass for U. S. Route 220 to Bedford. *Bedford Village* was settled about 1750, known then as *Raystown.* It was the site of an early trading post. *Fort Raystown,* later known as *Fort Bedford,* built in 1757 during the French and Indian War by Colonel John Armstrong, was enlarged and in July 1758 made a depot for the successful expedition of General John Forbes against the French at Fort Duquesne (now Pittsburgh). Later, during the Pontiac's War, Fort Bedford served as a base for the campaigns of Colonel Henry Bouquet. In 1794, during the Whiskey Rebellion, General George Washington at Fort Bedford reviewed the forces which were sent out to quell this uprising in western Pennsylvania. *Bedford Springs,* two miles south of town, has been famous for many years as a health resort. Medicinal value of these springs was discovered about 1796 and it soon became a leading resort. President James Buchanan used the Springs as his summer White House.	78.6
81.6	*Bedford Interchange.* The strata on the west side are WILLS CREEK consisting of greenish-yellow shale interbedded with dove-gray calcareous shale. Some cherty limestone occurs near the top of the 40′ cut. Near the ticket booth is a blue limestone replete with veins of calcite, quartz veins and vugs; some ostracoda are present. Strike N11°W, dip 12°NE.	78.4
81.75	McKENZIE limestone. Thin-bedded, fossiliferous limestone, interbedded with greenish-brown shale. The BLOOMSBURG red shale just discernible at the west end of the cut. Strike N13°W, dip 19°NE.	78.25
82.0	Colonial iron workings, pits and mounds in ROSE HILL (CLINTON) to north of Turnpike.	78.0
82.1	ROSE HILL shale unconformably overlain by stream gravel.	77.9
82.8	Axis of anticline plunging to the north.	77.2
83.0	ROSE HILL shale. Red and greenish-brown shale. Note Colonial iron pits and refuse mounds on top of the cuts, north of the Turnpike.	77.0
83.2	ROSE HILL shale. An "iron-rich" sandstone unit caps the cut. The ROSE HILL here is unique in consist-	76.8

ing of much red shale. Fossiliferous. Strike N72°E, dip 24°NW. This is on the nose of a plunging anticline.

83.4 WILLS CREEK greenish-brown soft shales. Shallow cut. 76.6

83.6 TONOLOWAY-WILLS CREEK CONTACT. WILLS CREEK at east end of 20-foot cut. Strike N34°E, dip 50°NW. 76.4

83.9 TONOLOWAY in a 15-foot cut, deeply weathered. Ostracoda. 76.1

84.3 Cross over Lincoln Highway, Route 30. 75.7

The *Forbes Road* of 1758 diverged from the path cut by Colonel Burd in 1755 at this point. The Forbes Road led westward through the wilderness to Ligonier. A few miles to the west, just east of Schellsburg, was the site of Shawnee Cabins, a village site on the Raystown Path, named for a group of Shawnee Indians which halted here on their retreat from the Potomac to the lower Allegheny in the early 1700's. The army of General Forbes marching against the French at Fort Duquesne (Pittsburgh) established a camp at this point.

84.8 HELDERBERG limestone group. This cut, about 60 feet high, is chiefly in the KEYSER, although some NEW SCOTLAND and COEYMANS may be seen at the west end of the cut. Strike N25°E, dip 64°NW. 75.2

To the south across the valley of the Juniata on the northern edge of the village of *Manns Choice*, there is "*Wonderlands Cave*" developed in the KEYSER limestone. The cave development occurs on steeply-dipping bedding planes in the KEYSER, particularly, on the top of a *Stromatoporoid* bed. The strike here is N48°E, dip 82°NW.

85.0 ORISKANY in a low 10-foot cut. The ORISKANY consists of decomposed RIDGELEY sandstone and SHRIVER chert. Few fossils. 75.0

85.4 NEEDMORE shale (ONONDAGA). Long, deep cut east of the bridge over the Turnpike at this point. The NEEDMORE is a fissile, black shale. Strike N20°E, dip 54°SE. 74.6

85.8 TULLY outcrops 2/10 mile east of the bridge in the center of the cut—*Lopholasma tullius zone, Emanuella zone,* well-developed. Strike N27°E, dip 87°SE. Exposures are good on both sides of the Turnpike. Note profile of *Wills Mountain* to east which reveals the rapid plunge of the anticline. 74.2

Mileage West-bound		Mileage East-bound
86.0	*Juniata River Crossing* (Raystown Branch). Burket, Tully, and Hamilton. Excellent fossil collecting; Tully limestone 8 feet thick with overlying Burket (Genesee) and underlying Moscow (Hamilton).	74.0
89.1-89.4	Portage "flags", interbedded shale and sandstone, in 30-foot cut. Strike N7°E, dip 13°SE.	70.6-70.9
91.4-91.5	Portage. Gray, arenaceous shale, some fissile black shale. Strike N50°E, dip 17°SE.	68.5-68.6
91.8	Portage, olive-drab shale in quarry north and northwest of bridge over Turnpike at this point. Fossiliferous.	68.2
93.0	South boundary, Bedford Quad.; north boundary Hyndman Quad.	67.0
94.85	*Kegg Maintenance Building.*	65.15
96.5	West boundary, Hyndman Quad.; east boundary, Berlin Quad.	63.5
96.8	*New Baltimore Gas Station (eb).* Across from the gas station, on the north side of the Turnpike, there is a small quarry of Chemung or Portage (?), olive-drab, interbedded, thin-bedded shale and sandstone. Raindrop impressions, and fucoid markings or worm tubes. Dip 10°NW.	63.2
98.0	Contact: Catskill-Chemung (pl. 13A). Close to the bridge over the Turnpike at the *Carmelite Mission.* The Chemung consists of interbedded olive-color, shale and platy, chocolate red sandstone. Fossils found include *Productella speciosa and Productella lachrymosa.*	62.0
98.0-102.9	Catskill interbedded red and green shale and red sandstone, thickness approximately 2,011 feet. The strata in this interval dip westward from 5° to 18°. Occasional *Ostracoderm (armor-plated fish)* plates are found, especially at *wb* 98.9-99.1 (*eb* 60.9-61.1), the *New Baltimore Slide.* This slide, a combination slump rock-slip has given constant trouble. It involves rock throughout the entire length of the cut and 1,250 feet back from the Turnpike. Many thousands of cubic yards of rock have been removed from this area. Note ripple marks on red sandstone, Plate 11B.	57.1-62.0
102.9	Contact: Pocono-Catskill (Hampshire of Darton).	57.1
103.65	*Allegheny Tunnel* (East Portal), Plate 16. The rock at the portal is the Burgoon sandstone at the top of the Pocono. Dip 8°NW. Most of the tunnel is in	56.35

MAUCH CHUNK shales. The east face of *Allegheny Mountain* consists of POTTSVILLE sandstone at the crest, MAUCH CHUNK shales below, resting on the POCONO sandstone at the level of the tunnel portal.

East-bound travelers turn to page 23 for a general description of Section 2: Blue Mountain—Allegheny Mountain.

SECTION 3. ALLEGHENY MOUNTAIN—IRWIN (55.2 miles)

Strip maps 6, 7, and 8 (pls. 26, 27, and 28)

The western portion of the Turnpike from Allegheny Tunnel to Irwin traverses two sections of the Allegheny Plateau physiographic province. From Allegheny Mountain westward to Chestnut Ridge the superhighway crosses a series of ridges and high plateaus which compose the Allegheny Mountain section. To the west of Chestnut Ridge is the Pittsburgh section, characterized by a dissected terrain of flat-topped hills.

The high plateau of the Allegheny Mountain section constitutes the highest physiographic unit in Pennsylvania. The average elevation of the Turnpike through the plateau area is 2,300 feet above sea level. A maximum elevation of almost 2,500 feet is attained when the highway crosses Negro Mountain. South of this point about 15 miles is Mt. Davis, a promontory on Negro Mountain with an elevation of 3,213 feet, the highest point in Pennsylvania.

Three prominent ridges are traversed by the Turnpike in the Allegheny Mountain Section. Negro Mountain, Laurel Hill, and Chestnut Ridge are anticlinal ridges, the up-folded rocks being expressed by the topography.

In the Pittsburgh section of the Allegheny Plateau, downcutting of the major stream system—the Ohio River and its tributaries—has resulted in an extremely dissected land surface. Erosion has carved the surface into irregular hills and steep-walled valleys. A conspicuous physiographic feature is the general accordance of the flat-topped hills. This surface is considered a remnant of the Allegheny peneplain, which is correlated with the Harrisburg peneplain, recognized to the east of Blue Mountain in the Cumberland Valley. The gently-folded underlying rocks have not exercised a dominant control over the topography as in the case of Laurel Hill and Chestnut Ridge.

The rocks exposed along the Turnpike from Allegheny Tunnel to Irwin range in age from Mississippian to Permian. Along much of this distance the coal-bearing strata of Pennsylvanian age are prominent. Mississippian shales, limestones, and sandstones are brought to the surface on the Laurel Hill and Chestnut Ridge anticlines. Capping the hilltops near the Irwin ticket booth are shales and sandstones of the Washington group, which have been assigned to the Dunkard series of Permian (?) age, the youngest rocks exposed along the Turnpike. Of greatest interest is the 1,500-foot sequence of coal-bearing beds which constitute the Pennsylvanian System. Along the route of the Turnpike we see many evidences of both underground and strip mining of the coal beds. The gently-folded character of the rocks and the dissected nature of the topography result in a repetition of the same sequence of rocks during the course of travel from east to west.

Mileage West-bound		Mileage East-bound
104.8	*Allegheny Tunnel* (West Portal). ALLEGHENY group. Dip 10°NW. On the gentle westerly slope of Allegheny Mountain, coal is mined both north and south of the Turnpike. In a small mine one-half mile northwest of the portal of Allegheny, the LOWER FREEPORT (*D*) coal is being mined. The strike is N45°E and the dip 8°NW. The coal occurs in two layers separated by 8 inches of "slate". The upper layer is 40 inches thick; the lower is 6 inches thick. Approximately 1½ miles southwest of the tunnel portal, at Shipley, both the LOWER FREEPORT (*D*) and the UPPER KITTANNING (*C′*) coals are mined. The LOWER FREEPORT coal is 30 inches thick, and the UPPER KITTANNING coal is 48 inches thick. They are separated by a 10-foot shale interval. On the west slope of Negro Mountain, the interval between these coals thickens to 26 feet.	55.2
105.5	BRUSH CREEK coal (23 inches). In this cut the fossiliferous Brush Creek shale is well exposed over the coal. Dip 7°W. Note the 6 feet of clay underlying the coal.	54.5
106.0	LOWER BAKERSTOWN coal blossom (18 inches) overlain by platy sandstone and underlain by clay and clay-shale.	54.0
106.25	UPPER BAKERSTOWN coal blossom (28 inches) overlain by a buff-colored, platy sandstone and underlain by fire clay. Dip west.	53.75
106.5	HARLEM coal (25 inches). Dip 4°W. MIDDLE of CONEMAUGH GROUP.	53.5
106.8	Bridge over the Turnpike, Shanksville to Roxbury. Here clay shales and slabby sandstone rest on the BARTON coal (15 inches), and are succeeded by one foot of clay shale, 2 feet of oolitic limestone featured by solution channels, and 2 feet of clay from a decomposed limestone. Dip 4°W.	53.2
107.2	WELLERSBURG coal (11 inches) resting on clay and limestone nodules. Dip 4°W.	52.8
107.45	*Stony Creek Bridge.* Note the waste pile of WELLERSBURG limestone south of the road, removed from the foundation excavations for the bridge.	52.55
107.5	AXIS BERLIN COAL BASIN.	52.5
108.0	WELLERSBURG (?) coal blossom (10 inches) resting on clay which may be residuum after limestone. Dip 4°E.	52.0
108.35	*Glades Creek Bridge.*	51.65

Mileage West-bound		Mileage East-bound
109.25	Lower Bakerstown coal (6 to 8 inches) underlain by a fire clay and black thin-bedded shale and arenaceous shale. Dip 5°E. Plate girder bridge over the Turnpike.	50.75
109.5	Brush Creek(?) horizon, blossom over and underlain by clay.	50.5
109.85	Bridge over the Turnpike. About 200 yards north and slightly west of the bridge, on the east slope of *Negro Mountain,* there is an extensive stripping operation in the Lower Freeport (*D*) coal. Here the coal is 44″ thick and is overlain by about 15′ of arenaceous shale and 4′ of top soil. The strike is N85°E, and the dip 5°SE. It is interesting to note that the *D* coal has thickened from 31 inches on the west flank of *Negro Mountain* to 44 inches on the east flank, and that the rider coal present on the west is absent on the east.	
111.0	*Negro Mountain Cut.* This cut is 67 feet deep, 1,500 feet long, and the sides are on a ¾ : 1 slope. It replaces an old formerly partially driven tunnel, the portals of which may be seen a few feet north of the Turnpike. The Upper Freeport (*E*) coal (28 inches) is exposed in this cut, and the thin Mahoning coal is seen just beneath the sandstone at the top of the cut. Approximately one-half mile to the south on west slope of Negro Mountain adjacent to State Route 31 at "Dead Man's Curve", extensive stripping of the *E* coal has been carried out. In this strip mine operation, the Upper Freeport coal varies in thickness from 36 to 44 inches, and a 7-inch rider coal overlies the *E* by approximately 5 feet, 8 inches.	49.0
111.5	Lower Freeport (*D*) coal stripping, north side of road. Very good exposures of the *D* coal and related beds are obtained in this excavation. Dip 5°NW. The section is:	48.5

Ft.	In.	
3		sandstone, coarse, gray
7		shale, arenaceous, gray
	6	coal—a rider coal above the Lower Freeport
5	2	shale
2	7	coal, Lower Freeport (*D*)

112.45	Bridge over the Turnpike—Route U. S. 219 (State Route 31)	47.55
112.9	Sandstone and shale in an irregular anticline showing dips 9°E and 6°W. On the hill above and north	47.1

of this cut there has been extensive coal stripping. In this stripping, both the LOWER FREEPORT (*D*) and the UPPER KITTANNING (*C′*) coals are exposed. The sequence of strata is:

FT.	IN.	
—		gray, fissile, arenaceous shale
	20	LOWER FREEPORT (*D*) coal
26	8	gray, thin-bedded shale and argillaceous sandstone
	8	boney coal, or roof slate
		UPPER KITTANNING:
		12″ coal (*C′*)
		12″ binder
		27″ coal (*C′*)

Several shafts and grade entries to mines in the *C′* coal occur in the immediate vicinity and include one at the Somerset County Home on State Route 31, north of the Turnpike, opposite *wb* 114.7 (*eb* 45.3).

114.2 *Somerset Maintenance Building.* From here westward to the Somerset gas station are minor folds which bring some thin coals to the surface. 45.8

114.7 *Somerset gas station (wb).* 45.3

115.05 Bridge over the Turnpike. Crossing of State Route 31. LOWER FREEPORT (*D*) coal exposed in cut at east end of bridge. 44.95

115.6 *Coffee Springs Farm Mine.* In part this mine was dug out, and that portion beneath the Turnpike right-of-way backfilled with suitable material. The old shaft is on the high bank to the south, and several entries may be seen in the low ground to the north. The coal mined was the UPPER KITTANNING (*C′*). Dip 3½°W. The sequence of strata exposed in backfilling this mine was: 44.4

FT.	IN.	
4		sandstone, platy, buff
12		interbedded shale and sandstone
	1	boney coal
	16	UPPER KITTANNING coal (*C′*)
	6	carbonaceous shale
1	6	fire clay
7		sandstone, argillaceous, gray, and interbedded, black arenaceous shale

116.55 Bridge over the Baltimore & Ohio RR. Near the MIDDLE ALLEGHENY; the rock strata become younger eastward. 43.45

Mileage West-bound		Mileage East-bound
116.8	Approximate contact of Conemaugh and Allegheny groups.	43.2
117.1	*Somerset Interchange,* Plate 2A, connects with U. S. Route 219. From here to Quemahoning cut the rocks are Conemaugh or "Lower Barren Coal Measures" and show thin coals, typical shales, sandstones, and a little limestone. Harmond Husband, leader of the North Carolina revolt against the British, fled under an assumed name in 1771. He became *Somerset's* first settler, living at *Coffee Springs Farm* for some years. Husband became a pamphleteer and was active in the Whiskey Rebellion.	42.9
120.7	*Quemahoning Cut.* Old tunnel still open a few feet north of and below the Turnpike grade. The rock in this cut consists of 30 feet of arenaceous shale and thin-bedded sandstone in the upper part and clay-shales in the lower 45 feet. The strata are approximately horizontal. This cut has a maximum depth of 85 feet and is 1,250 feet long. The rock is typical of the Upper Conemaugh.	39.3
121.05	*Abandoned limestone mine* crossed by Turnpike. The entrance was walled up and the mine filled with dry, crushed slag.	38.95
121.95	Fresh-water limestone, 7 to 8 feet thick, weathers buff, and just north of the Turnpike right-of-way an old limestone quarry in the same rock. Dip 1°E.	38.05
122.6-122.7	Ames limestone and Harlem coal. In this large cut are the best exposures of the Ames and the Harlem to be seen on the Turnpike. They are best observed at the west end of the cut on the north side of the road: Dip 3°E.	37.3-37.4

Section:

Ft.	In.	
		sandstone, platy, buff; top of cut
	6	carbonaceous shale (Berlin coal horizon)
8		clay
40		shale, gray, concretionary
9		Ames, black, calcareous shale. Very fossiliferous
	16	Harlem coal
	—	clay-shale, nodular

123.4	Top of Brush Creek black shales.	36.6
123.5	Brush Creek coal (12 inches) and overlain by fossiliferous Brush Creek shale. Clay underlies the	36.5

Mileage West-bound		Mileage East-bound
	coal. A fossil starfish was collected at this locality. Dip 4°E.	
123.9	Upper Freeport coal (*E*), Plate 18. Contact: Allegheny-Conemaugh groups. Pit posts at former entries to the *Mary Bell Mine* may be seen, but slumping of the bank largely conceals the section (north side of road):	36.1

Ft.	In.	
4		shale, thin-bedded carbonaceous
	30	Upper Freeport (*E*) coal
	2	slate binder
	2	coal
	1	slate binder
	7	coal

	Because of the danger of subsidence of the road over the workings, the balance of the coal in the mined area underlying the right-of-way was completely removed and the excavation backfilled with suitable material.	
124.2	*Laurel Hill Gas Station (eb).* Opposite the gas station, and in the low cuts toward the west, several beds of coal varying from 14 to 28 inches in thickness may be observed dipping approximately 4°E. The fragmentary character of the exposures precludes positive identification of individual beds.	35.8
124.55	Contact(?): Pottsville series-Allegheny group Dip 6°E. Low cut exposing 12 feet arenaceous shale, 2 feet carbonaceous shale, 5-inch binder slate, 7-inch coal (Brookville?), and 5 feet of platy to medium-bedded, argillaceous sandstone (Homewood?).	35.45
124.85	Contact: Mauch Chunk group-(Mississippian) and Pottsville series (Pennsylvanian). Red Mauch Chunk shale overlain by the platy, medium-bedded Pottsville sandstone. Dip 3°E, the strata rising westward toward the Laurel Hill anticline.	35.15
125.15-125.45	Mauch Chunk red and green shales with interbedded, cross-bedded, platy sandstone. Dip 2°E.	34.55-34.85
125.9	Mauch Chunk medium- to massive-bedded, olive-colored sandstone, overlain by red, earthy, and lumpy shale. These strata are exposed in a long cut on the north side of the Turnpike. On the south side, down the hill slope, there is a small abandoned quarry in the Loyalhanna arenaceous limestone from which stone was quarried in 1885 for two arch structures in the two valleys east of this point.	34.1

Mileage West-bound		Mileage East-bound
126.2	*East Portal Laurel Hill Tunnel.* The East Portal of the tunnel is in the Mauch Chunk, which is here a platy argillaceous sandstone with occasional red shale interbeds. Dip 2°E. The tunnel is cut in the basal part of the Mauch Chunk and the underlying Loyalhanna arenaceous limestone. The tunnel has a total length of 4,541 feet. Because of the caved condition of the old east portal a new heading was driven.	33.4
127.45	*West Portal Laurel Hill Tunnel.* The Loyalhanna is exposed at the portal, dipping 2½°E. It is 62 feet thick in the tunnel.	32.55
127.9	Loyalhanna *limestone quarry.* This quarry is about 500 feet south of the Turnpike and was opened and operated for the highway construction. The Loyalhanna, having the same thickness and dip as in the tunnel, is overlain by and is transitional with the Mauch Chunk throughout a 20-foot zone. Vertical jointing is prominent, and weathering along the joints has produced "sand seams" ranging from one inch to 7 feet in width. The Loyalhanna "limestone" is a massive, calcareous, fine- to medium-grained sandstone in this locality, although because of usage over a wide area it is often called a siliceous or arenaceous limestone. The latter terminology is generally employed in this text. On fresh surfaces it is usually bluish to greenish gray in color, thus accounting for the local name "blue stone". One of the most distinctive characteristics is its cross-bedding. This cross-bedding is of the type generally attributed to wind blown deposits. The Loyalhanna is one of the key beds in southwestern Pennsylvania.	32.1
128.5	Crossing approximate crest of Laurel Hill anticline. The axis strikes approximately N40°E.	31.5
129.1	Burgoon sandstone, upper Pocono (Mississippian age), exposed on north side of highway. The Loyalhanna limestone and Burgoon sandstone are logged by drillers as the Big Injun sand in the southwestern corner of the State where they are productive of gas and some oil.	30.9
129.5	Loyalhanna arenaceous limestone, poorly exposed on the north side of the road, close to grade. Dips 5°W.	30.5
129.7	Contact: Pottsville series-Mauch Chunk group. The Mauch Chunk consists of interbedded, blocky sandstone and soft, earthy, red shale. Dip 7°W. Pottsville series is exposed from here to 130.15 *wb*	30.3

Mileage West-bound		Mileage East-bound
	(29.85 *eb*). The upper Pottsville member, the Homewood sandstone, is quite massive.	
130.15	Pottsville sandstone; the contact with the Allegheny group is concealed, but from this point eastward to 129.3 *wb* (30.3 *eb*) the Pottsville sandstone is excellently exposed. Locally, it is conglomeratic; in part it is iron-stained. Generally, it is a medium-bedded, slabby, strongly cross-bedded sandstone.	29.85
131.1	Upper Kittanning (*C′*) coal. See in the cut east of the bridge over the Turnpike at this point. Dips 5°W. The section seen:	28.9

Ft.	In.	
10		shale, arenaceous, thin-bedded
6		carbonaceous shale, fissile
		Upper Kittanning coal
1½		coal
	3	binder slate
	4½	coal
	5	sandstone, buff-colored
2½		limestone, dark-gray, nodular
8		fire clay, gray
	—	sandstone, fine-grained, medium bedded, lenses eastward into clay-shale

131.9	Contact: Conemaugh-Allegheny groups. The Upper Freeport coal, which is brought to the surface at this point, is missing over much of this local area.	28.1
134.05	Brush Creek horizon, dip ½°W.	25.95
134.7	Lower Bakerstown coal adjacent to the overhead bridge. Here 10 feet of black fissile shale rests on 8½ inches of Lower Bakerstown coal, which in turn rests on 12 feet of gray fire-clay. The average dip is 2°W although several irregular "rolls" are present.	25.3
135.1-135.2	Woods Run limestone above the Bakerstown in the Conemaugh section, 3 feet thick, nodular, underlain by variegated red shale. It dips 2°E and disappears beneath the grade of the road at the bridge (134.7 *wb;* 24.9 *eb*).	24.8-24.9
135.5	Brush Creek coal and shale, similar to the exposure cited above, but here the coal is only 7 inches thick.	24.5
135.95	Brush Creek coal and shale. This cut, immediately east of the bridge over the Turnpike at the east end of the Donegal interchange, exposes a 9-inch layer of Brush Creek coal, 20 feet of the overlying, fossiliferous Brush Creek shale, and a fire-clay underlying the coal that contains iron-rich concretions.	24.05

Mileage West-bound		Mileage East-bound
136.3	*Donegal Interchange.* Connects with state routes 711 and 31 (U. S. 219). On the north side of the Turnpike, in the cut, the Brush Creek coal horizon and the Brush Creek shale may be seen. A few miles to the north is *Ligonier,* site of *Fort Ligonier,* built in 1758 as a base for the Forbes expedition. Under Colonel James Burd the fort withstood attack by French and Indians on October 12, 1758. Ligonier was the only small fort in the West not taken in the Pontiac's War in 1763. As a result Bouquet's rescue of Fort Pitt was made possible.	23.7
136.65	*Donegal Cut,* immediately west of the *Donegal Interchange.* In this deep cut the strata are roughly horizontal and comprise the Buffalo shales and sandstone (lower Conemaugh). The former consist of hard and gray clay shales containing limestone nodules, and the latter coarse, buff, channel sandstone.	23.35
137.3-138.1	Brush Creek fossiliferous shale is observed, dipping 3°E, and with it the Brush Creek coal, 6 inches thick. The exposures occur both east and west of the bridge over the Turnpike at 138.1 *wb* (21.9 *eb*).	21.9-22.7
139.05-139.35	Contact: Allegheny-Conemaugh groups. In this cut, and just east of the bridge over the Turnpike, the Mahoning sandstone of the Conemaugh group rests on the Upper Freeport coal, which varies from 10 to 18 inches thick. The dip is 2°W, indicating the presence of a minor fold on the east limb of the Chestnut Ridge anticline.	20.65-20.95
139.75	Contact: Pottsville series-Allegheny group. The strata are here dipping 4°E. The Pottsville sandstones, which produce considerable rubble, account for the rugged topography in the gorge-like valley of Jacobs Creek on the west flank of Chestnut Ridge. The Turnpike crosses Jacobs Creek at this point. The lower portion of the Allegheny group with its coals may be seen between the creek crossing and the overhead bridge.	20.25
140.25	Contact: Mauch Chunk-Pottsville. Mauch Chunk is overlain by Pottsville sandstone; the strata dip 5°E.	19.75
140.45	Crest of Chestnut Ridge anticline. Twenty-five miles to the southwest along the axis of this anticline is a pronounced structural dome on which is located the *Summit gas field.* The gas is produced from the Onondaga and Oriskany formations of Devonian age.	19.55
140.65-141.65	Top Greenbrier limestone. It consists of 14 feet of massive limestone which overlies 10 feet 5 inches of	18.35-19.35

Mileage West-bound		Mileage East-bound
	interbedded calcareous shale and limestone. Mauch Chunk red shales overlie the Greenbrier member. At 140.65 *wb* (19.35 *eb*) in the calcareous shale, fossils are abundant. Dip 2°W.	
141.75	Contact of Pottsville series-(Pennsylvanian) Mauch Chunk group (Mississippian) occurs here but is concealed. Upper portion of the Mauch Chunk exposed in 45-foot cut, on north side of Turnpike, with red shale in the top and bottom of the cut, separated by a gray sandstone and shale.	18.25
142.15-142.25	Pottsville. A sequence of medium-bedded to platy sandstones, black shales, clay shale, and an occasional coal blossom. Dip 8°W.	17.75-17.85
142.6	Allegheny group. Dip 10°W. Thirty-four inches black shale with coal stringers, underlain by platy sandstone, fine-grained, a two-foot bed of limonitic concretions, and a stratum of clay-shale. Exact position of these strata in the Allegheny group is not known. Contact: Allegheny and Pottsville (concealed).	17.4
143.0-143.15	Lower Conemaugh and Upper Allegheny strata dipping 7°NW on the west flank of Chestnut Ridge. The Upper Freeport coal is considered the top of the Allegheny group.	16.85-17.0

Section:

Ft.	In	
12		Brush Creek shale, thin-bedded and carbonaceous; fossiliferous
	7½	Brush Creek coal
15		clay-shale or fire clay, gray
20		Mahoning sandstone series 4′ sandstone, fine-grained, gray with lenses of clay-shale 10′ variegated red and green shale 4′ bed of limonitic concretions and nodules 0-15′ Mahoning sandstone, fine-grained, gray
4		Upper Freeport (*E*) coal. This is deeply channeled by the Mahoning sandstone. The typical coal section is: 22″ coal 1″ binder slate 13″ coal 1″ binder slate 11″ coal
15		Zone of limonite nodules.

South of the Turnpike, and below the highway grade, are two accessible, abandoned entries into the LOWER FREEPORT (*D*) coal.

143.4 Bridge over Turnpike. 16.6

SALTSBURG sandstone, platy to medium-bedded with occasional interbeds of carbonaceous material which is high in sulphur content.

143.75 *Mt. Joy Cut.* LOWER UPPER CONEMAUGH section; dip 4°-8°W. This cut is 97 feet deep, 1,200 feet long, nearly 300 feet wide at the top, and necessitated 500,000 cubic yards of excavation. The upper 75+ feet of strata consist of the MORGANTOWN sandstone—massive, medium-grained, cross-bedded, and micaceous. Immediately underlying is the WELLERSBURG coal, 1 foot, 9 inches thick. Beneath the coal is the WELLERSBURG clay containing limestone nodules. Underlying the clay is the BIRMINGHAM shale, sandy in part. The WELLERSBURG coal thickens, thins, and splits in this cut. Local rolls and steepening of dips may be observed. 16.25

144.05 UPPER CONEMAUGH group. Dip 4°W. 15.95

Section:

FT.	IN.	
12		CONNELLSVILLE sandstone and shale
	3	LITTLE CLARKSBURG coal
19		sandstone, shaly and "punky"
1		shale, thin-bedded, black
3		sandstone, argillaceous, "punky"
2	8	CLARKSBURG limestone with secondary iron-rich concretions
1	7	shale with iron-rich concretions
—		shale, arenaceous, "lumpy"

144.5 PITTSBURGH coal crop line. CONTACT: MONONGAHELA and CONEMAUGH groups. Note extensive strip mining in REDSTONE and PITTSBURGH coals both north and south of the Turnpike. Dip 4°NW. The coal averages 8 feet, 4 inches thick in this area. At the crop line, at this location, extensive excavation was carried out during construction in order to protect the Turnpike from future subsidence, Plate 19. This is the easternmost occurrence of the PITTSBURGH and REDSTONE coals on the Turnpike. 15.5

144.65 REDSTONE coal and limestone. This coal shows a thickness of 66 inches with binders. It is overlain by about one foot of shale and thin-bedded, platy sandstone, and underlain by 5+ feet of REDSTONE limestone. Slumping of the bank partially conceals the section. 15.35

Mileage West-bound		Mileage East-bound
144.9-145.3	*Mine settlement area.* The Pittsburgh coal underlies this area at a depth of over 150 feet. It was mined from beneath the Turnpike right-of-way after construction, with consequent settlement of the highway. The strata exposed along the highway and in the railway cut include the Benwood limestone, the Sewickley sandstone and coal, and the Fishpot limestone. The Sewickley coal is approximately 4 feet thick and overlies 10 feet of thin-bedded sandstone and arenaceous shale. Beneath this sandstone are 6 feet of black, platy to massive limestone.	14.7-15.1
145.3-146.5	Benwood limestone. These exposures show the Benwood as a dense, gray limestone in beds 1 to 2 feet thick, interbedded with dark-gray soft shale in beds 8 to 18 inches thick. These outcrops are close to the axis of the Latrobe syncline.	13.5-14.7
147.1	Benwood limestone nodules in bank.	12.9
147.95	Redstone coal and blossom, approximately 44 inches thick, underlain by the partially decomposed Redstone limestone, which is about 5 feet thick. Dip 2°E.	12.05
148.1	Pittsburgh coal beneath Turnpike immediately west of the bridge over the Turnpike, Plate 19. Note the old mine entry and waste dumps as well as evidences of mine subsidence south of the right-of-way. Extensive mine settlement existed at this location, consequently, during Turnpike construction the strata were excavated to a level beneath the coal, and the area backfilled with suitable material. The mine opening above the level of the Turnpike is on the Redstone coal.	11.9
148.2	Approximate contact of Conemaugh and Monongahela groups.	11.8
148.5	Bridge over township road.	11.5
148.65	Red soft shale containing 3 limestone beds varying from 1 to 2 feet thick, aphanitic, gray, brecciated, thought to be Upper Clarksburg limestone. These strata are overlain by brown platy sandstone, Connellsville(?). Dip 6°E.	11.35
149.75	Black shale containing limestone nodules, very fossiliferous. Dip 2°E.	10.25
150.0-150.05	Brush Creek shale(?), slightly calcareous and fossiliferous, (pelecypods, gastropods, and brachiopods). Overlain by the Pine Creek limestone(?), locally aphanitic, about 18 inches thick. Outcrop	9.95-10.00

Mileage West-bound		Mileage East-bound
	seen in second rubble ditch east of the bridge. The BUFFALO sandstone appears to be absent.	
150.2	*New Stanton Gas Station (wb).* Approximate CONTACT: ALLEGHENY and CONEMAUGH groups. Crop of the UPPER FREEPORT coal, north side of the Turnpike, just east of the gas station and the township road. Dip E.	9.8
150.6	MAHONING sandstone. CONEMAUGH group overlying UPPER FREEPORT coal, above grade to north of Turnpike. Gray, platy sandstone with interbedded shale.	9.4
150.8	Crossing AXIS of FAYETTE ANTICLINE separating GREENSBURG and LATROBE-CONNELLSVILLE COAL BASINS.	9.2
151.0	MAHONING sandstone and shale underlain by the UPPER FREEPORT (*E*) coal, 4 feet thick with a 2- to 3-inch binder in the lower portion of the bed.	9.0
151.1	Bridge—note the entry (north) to the *Catherine Coal Company* mine into the UPPER FREEPORT (*E*) coal.	8.9
151.3-151.6	*New Stanton Viaduct and Interchange* (pl. 2B): the viaduct passes over Route 117, a trolley line, Big Sewickley Creek, and the Southwest Pennsylvania Railroad.	8.4-8.7
151.9	*West End New Stanton Interchange:* here the BRUSH CREEK shale and coal are again exposed.	8.1
152.1	BUFFALO sandstone, yellowish-brown, thin-bedded, platy, and micaceous, on north side of Turnpike. Underlain by the BRUSH CREEK shale and coal, exposed in the creek bed on the south side of the road. The shale is black, calcareous, and fossiliferous. Associated with the shale are 16 inches of BRUSH CREEK coal.	7.9
152.2	*Hempfield Gas Station (eb).*	7.8
152.8	GREENSBURG SYNCLINE, occasional exposures of CONEMAUGH shales.	7.2
155.0	GRAPEVILLE ANTICLINE, separating the IRWIN and the GREENSBURG COAL BASINS, OR SYNCLINES. The dip on the west flank is 2°.	5.0
155.8-156.4	Red and green shales and thin limestones (CLARKSBURG) characteristic of the CONEMAUGH.	3.6-4.2
156.4	*Arona Cut,* Plate 9A. This high cut is the result of a slump type of slide that occurred during construction. Movement was facilitated by intersecting vertical joints. The strata dip 7°NW, belong in the CONEMAUGH group, and consist of 20 to 30 feet of overlying medium-bedded sandstone underlain by	3.6

soft, red shale with interbedded 2- and 3-foot beds of CLARKSBURG limestone.

156.55 *Arona viaduct* over Little Sewickley Creek and the Hempfield branch of the Pennsylvania Railroad. Pittsburgh coal on north, culm pile on south. 3.45

A short distance to the northeast was *Fort Allen*, a post built by Pennsylvania German pioneers in 1774 as a refuge from the Indians in Dunsmore's War and the American Revolution.

157.0 Bridge over Turnpike. In the cut the following section is observed: 3.0

FT.	IN.	
18		CONNELLSVILLE sandstone; gray, cross-bedded, platy sandstone and interbedded, sandy shale
2	6	Carbonaceous shale and coal stringers
	8	LITTLE CLARKSBURG coal
2		UPPER CLARKSBURG limestone, gray, brecciated, contains secondary, nodular hematite and *Spirorbis*. Dip 5°NW

157.3 CONEMAUGH group: LITTLE PITTSBURGH coal, one-half inch thick, resting on the 1-foot thick LOWER PITTSBURGH limestone. 2.7

157.55 PITTSBURGH coal, in abandoned openings, right and left of the Turnpike. Extensive strippings on the north side exposes the coal and the overlying micaceous sandstones and shales. Dip 4°NW. This coal marks the base of the MONONGAHELA group. 2.45

157.85 REDSTONE limestone, dove-gray, interbedded with shale. It is 5 feet thick. A one-inch "stringer" of coal occurs at the west end of the cut. Channeling, which preceded the deposition of the overlying sandstone, cut out the coal and a portion of the limestone. 2.15

A few miles north, at *Bushy Run*, now a state park, an army under Colonel Henry Bouquet defeated the Indians on August 5-6, 1763. This lifted the siege of Fort Pitt and opened the gateway for settlement of the West.

159.8 First cut of the interchange. These strata are in the MONONGAHELA formation, located structurally on 0.2

MILEAGE WEST-BOUND | MILEAGE EAST-BOUND

the east flank of the IRWIN-PORT ROYAL SYNCLINE, dip 2°W.

Section:

Ft.	In.	
20-24		arenaceous gray shale, upper 10 feet strongly weathered
6	6	WAYNESBURG coal

Ft.	In.	
	11	coal—(Upper Bench)
	11	fire clay
1	10	coal—(Middle Bench)
1	11	fire clay
	9	coal—(Bottom Bench)

	11	fire clay and shale
	5	thin-bedded, platy, micaceous sandstone

The WAYNESBURG coal is generally considered as marking the top of the MONONGAHELA group and the PENNSYLVANIAN System. The shale which caps the coal section presented above would belong then to the DUNKARD series of PERMIAN age.

160.0 *Irwin Ticket Booth.* 0.0

East-bound travelers turn to page 39 for a general description of Section 3: Allegheny Mountain—Irwin. General information relative to the geologic itinerary is given on page 19.

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* A list of publications of the Pennsylvania Topographic and Geologic Survey is available on request.

PLATE 2. A. Aerial view of the Somerset interchange, looking east.

B. Looking west toward the New Stanton interchange where rocks of the lower Conemaugh group are exposed.

Plate 3. A. Midway service stations and restaurant near Bedford. Evitts Mountain rises to the east in the left background.

B. West portal of Rays Hill Tunnel, in Catskill red beds. Crest ridge formed by Pocono sandstone.

C. View through a Turnpike tunnel. The tunnels are ventilated by forced air through ducts opening into the roof.

PLATE 4. A. Typical bridge carrying a highway over the Turnpike.

B. Rock fill 98 feet high, west of Clear Ridge cut.

Plate 5. A. Harrisburg peneplain and Kittatinny Mountain seen from the Turnpike near the Carlisle interchange. Cottages in the foreground are along Conodoquinet Creek.

B. East portal of Blue Mountain Tunnel as found at the beginning of Turnpike construction.

PLATE 6. A. Doubling Gap from the Turnpike; Kittatinny Mountain here doubles back on itself, making two hairpin loops, each five miles long.

B. Turnpike passes eastward between Knob Mountain on the left and Timmons Mountain on the right. Timmons Mountain is a south-plunging synclinal re-entrant in Kittatinny Mountain. The Tuscarora sandstone forms the crest of Knob Mountain, a north-plunging syncline.

C. Cambro-Ordovician limestone dipping to the southeast near the Willow Hill interchange. Rosebud concretions are abundant in some limestones of this general locality. Knob Mountain in center background and Timmons Mountain on the right.

PLATE 7. A. Wills Creek shale exposed in a cut near Burnt Cabins; Sidneys Knob, to the south, is a north-plunging anticlinal fold.

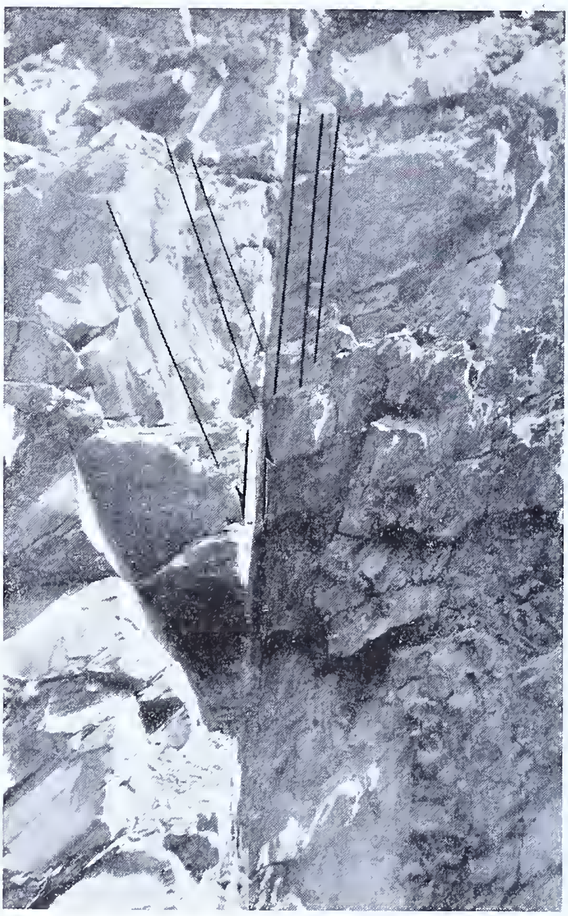
B. Gobblers Knob to the west of Burnt Cabins, lies at the south end of an anticline which brings up the Tuscarora sandstone to form Shade Mountain on the east and Blacklog Mountain on the west.

PLATE 8. A. View from Sideling Hill west toward Rays Hill. The synclinal valley is underlain by Mississippian rocks. Pocono sandstone forms the crest of both Sideling and Rays hills.

B. View to the west, with the level crest of Tussey Mountain in the background.

C. Water gap in Tussey Mountain to the west; Everett in the foreground.

Plate 9. A. Arona slide in Conemaugh beds during Turnpike construction. Note surface scarp of this slump-type slide which was facilitated by intersecting vertical joint systems. (Photograph by Pa. Turnpike Commission.)



B. Vertical fault plane in Martinsburg formation at the west portal of Kittatinny Mountain Tunnel.

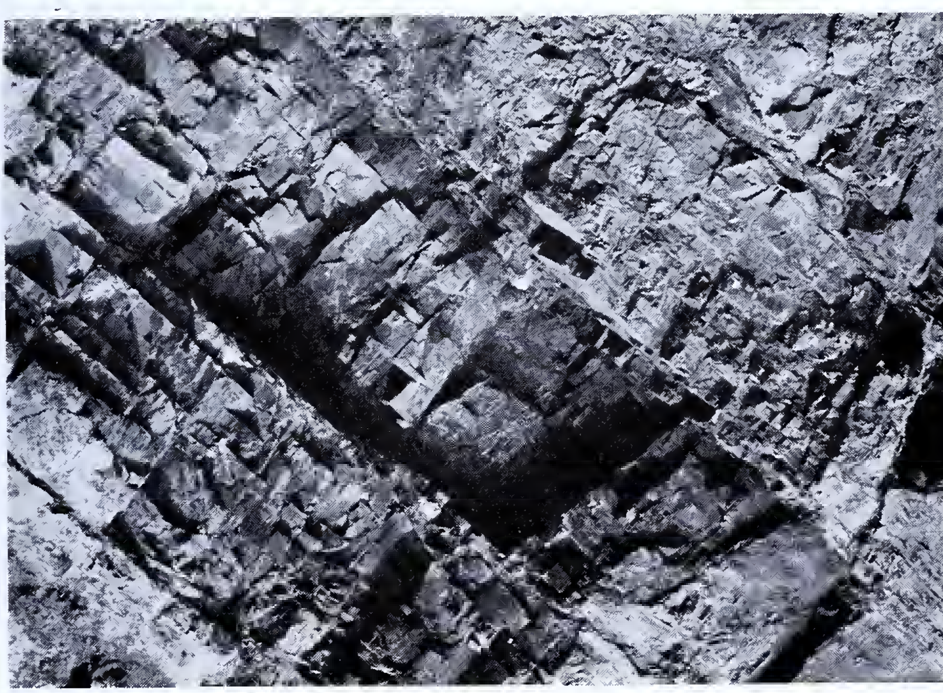
PLATE 10. A. Beekmantown dolomitic limestone exposed in a railroad cut east of Tyrone and north of the Turnpike.

B. Folded Wills Creek shale in the cut at the west portal of Tuscarora Tunnel. Note cleavage dipping steeply to the left. (Photograph by Pa. Turnpike Commission.)

PLATE 11. A. Harrell shale exposed in a cut on the ramp at the south side of the Fort Littleton interchange. (Photograph by Pa. Turnpike Commission.)

B. Massive ripple-marked Catskill sandstone exposed at the New Baltimore slide. (Photograph by Pa. Turnpike Commission.)

PLATE 12. A. Interbedded Catskill sandstone and thin shales in the excavation for the approach to the west portal of Rays Hill Tunnel. (Photograph by Pa. Turnpike Commission.)



B. Close view of the Catskill rocks in the cut at the west portal of Rays Hill Tunnel pictured above. (Photograph by Pa. Turnpike Commission.)

PLATE 13. A. Contact of typical Catskill red beds (left of figure) and Chemung (right) along the Pennsylvania Railroad west of Altoona, to the north of the Turnpike.

B. Cross-bedded Pocono sandstone in the excavation for the west portal of Sideling Hill Tunnel. (Photograph by Pa. Turnpike Commission.)

PLATE 14. A. Mt. Dallas cut seen from south, across Raystown Branch near Everett. The crest of Tussey Mountain, a long narrow ridge, is formed by steeply east-dipping sandstones and quartzites of the Tuscarora formation which are more resistant than the limestones to the west and the shales to east. The gap cut through Tussey Mountain by the Raystown Branch is possibly localized at this point due to the presence of a shear fault.

B. Tuscarora sandstone in the Mt. Dallas cut west of Everett.

PLATE 15. A. Kittatinny Mountain Tunnel as found at the beginning of Turnpike construction. Other of the old tunnels were found to be badly caved and dangerous.

B. Completed entrance to Kittatinny Mountain Tunnel, a typical Turnpike tunnel portal.

Plate 16. A. East portal of Allegheny Mountain Tunnel during construction.

B. Forms in place for concrete lining of a tunnel.

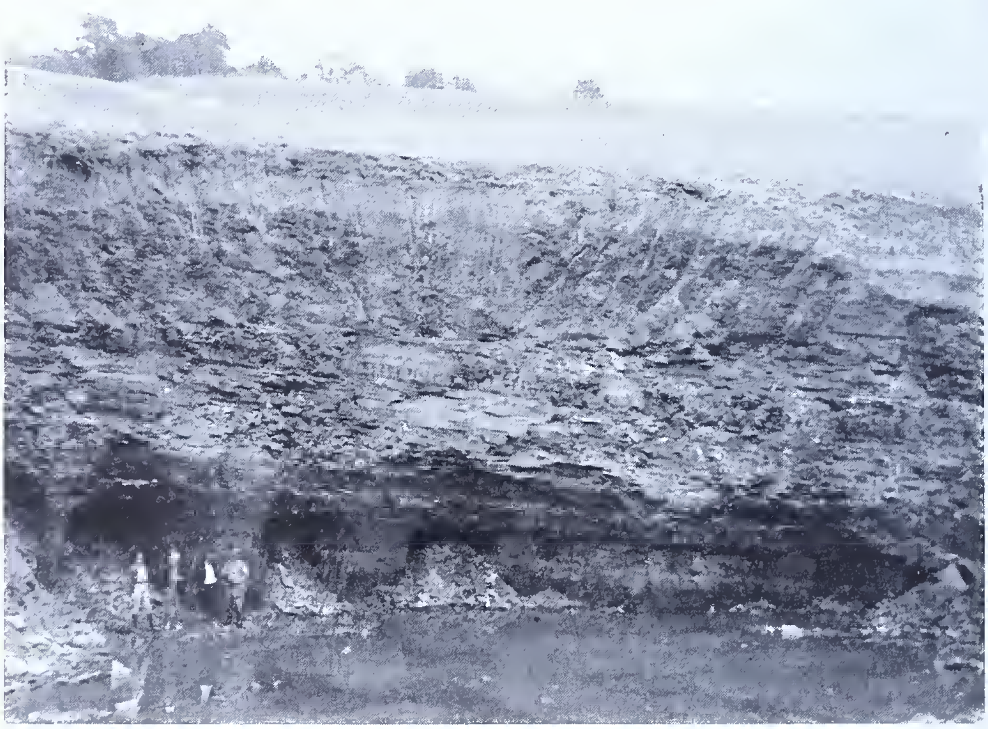
Plate 17. A. Clear Ridge cut during construction. This cut, 153 feet deep and 2,475 feet long, is the deepest highway cut in the eastern United States. The cut is benched at 30 feet and 80 feet above the roadway to provide drainage and control rock falls. Material from this cut was used in the 98-foot fill to the west.

B. Clear Ridge cut completed. Excellently exposed in this cut is a thick sequence of interbedded Chemung sandstone and shale which grades into the Catskill red beds near the east end.

PLATE 18. A. Upper Freeport coal mine east of Laurel Hill Tunnel back-filled during Turnpike construction. Tar-coated drainage pipes (lower left) were placed beneath the roadway to carry mine waters.

B. Close view of the coal, showing its thickness and character. Note preparations for back-filling.

Plate 19. A. Turnpike excavation exposed an abandoned mine in the Pittsburgh coal.



B. Excavation to base of Pittsburgh coal for the foundation of an overpass bridge.

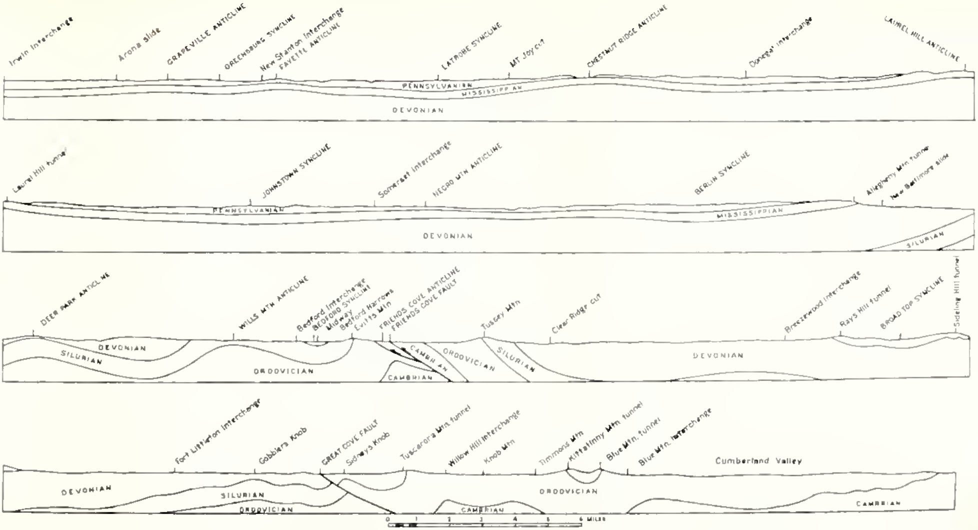


Plate 20. Generalized geologic cross section from Cumberland Valley to Irwin along the approximate route of the Turnpike (after F M Swartz).

PLATE 21. Pennsylvania Turnpike geologic strip map No. 1

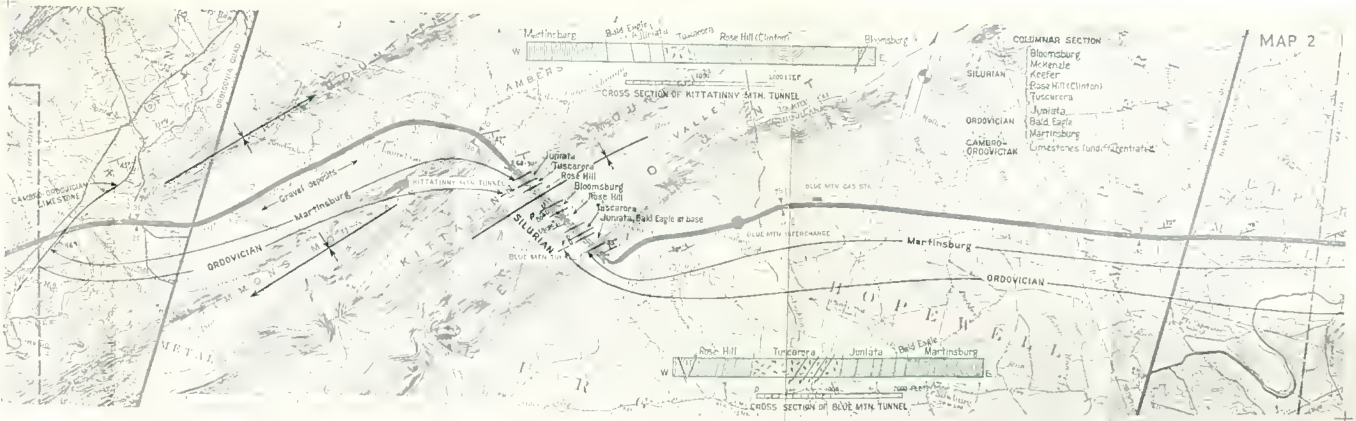
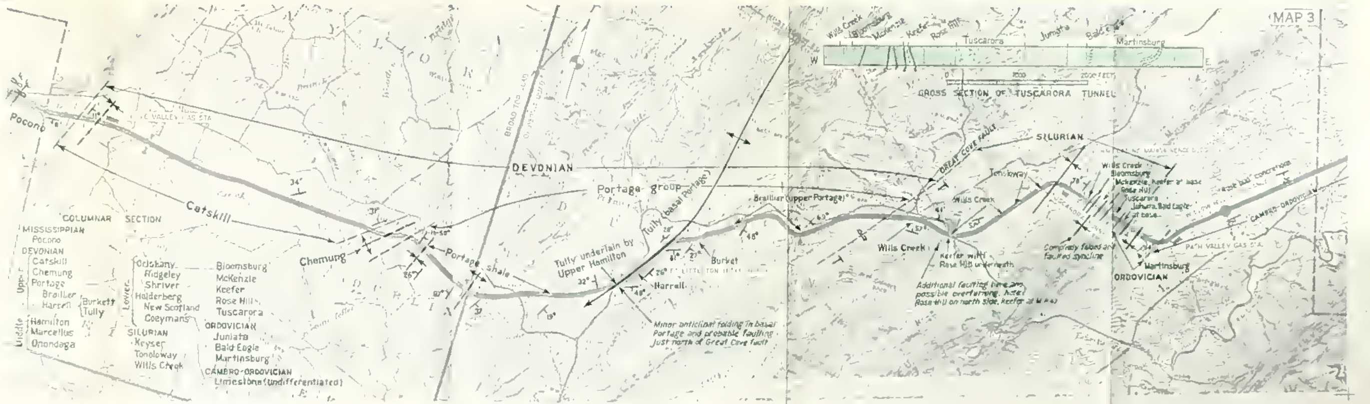


Plate 22. Pennsylvania Turnpike geologic strip map No. 2.


MAP 3
Wills Creek
Bloomsburg
McKenzie
Keefer
Rose Hill
Tuscarora
Juniata
Bald Eagle
Martinsburg
W
E
CROSS SECTION OF TUSCARORA TUNNEL
Pocono
DEVONIAN
Portage group
Catskill
Chemung
Portage shale
Tully (basal Portage)
Tully underlain by Upper Hamilton
Brallier (upper Portage)
Burket
Harrell
GREAT COVE FAULT
SILURIAN
Tonoloway
Wills Creek
Keefer with Rose Hill underneath
Additional faulting here and possible overturning. Notes Rose Hill on north side, Keefer at base
Minor anticlinal folding in basal Portage and probable faulting just north of Great Cove fault
Complexly folded and faulted syncline
Wills Creek
Bloomsburg
McKenzie, Keefer at base
Rose Hill
Tuscarora
Juniata, Bald Eagle at base
Martinsburg
ORDOVICIAN
CAMBRO-ORDOVICIAN
PATH VALLEY GAS STA.
BROAD TOP ROAD
COLUMNAR SECTION
MISSISSIPPIAN
Pocono
DEVONIAN
Upper
Catskill
Chemung
Portage
Brallier
Harrell
Burkett
Tully
Middle
Hamilton
Marcellus
Onondaga
Lower
Oriskany
Ridgeley
Shriver
Helderberg
New Scotland
Coeymans
SILURIAN
Keyser
Tonoloway
Wills Creek
Bloomsburg
McKenzie
Keefer
Rose Hill
Tuscarora
ORDOVICIAN
Juniata
Bald Eagle
Martinsburg
CAMBRO-ORDOVICIAN
Limestone (undifferentiated)

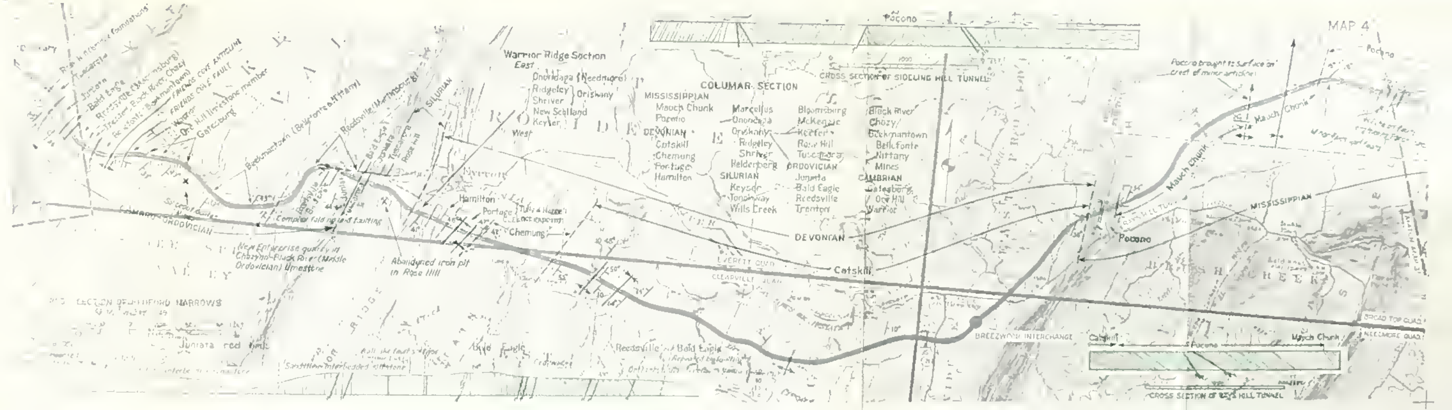


Plate 24. Pennsylvania Turnpike geologic strip map No. 4

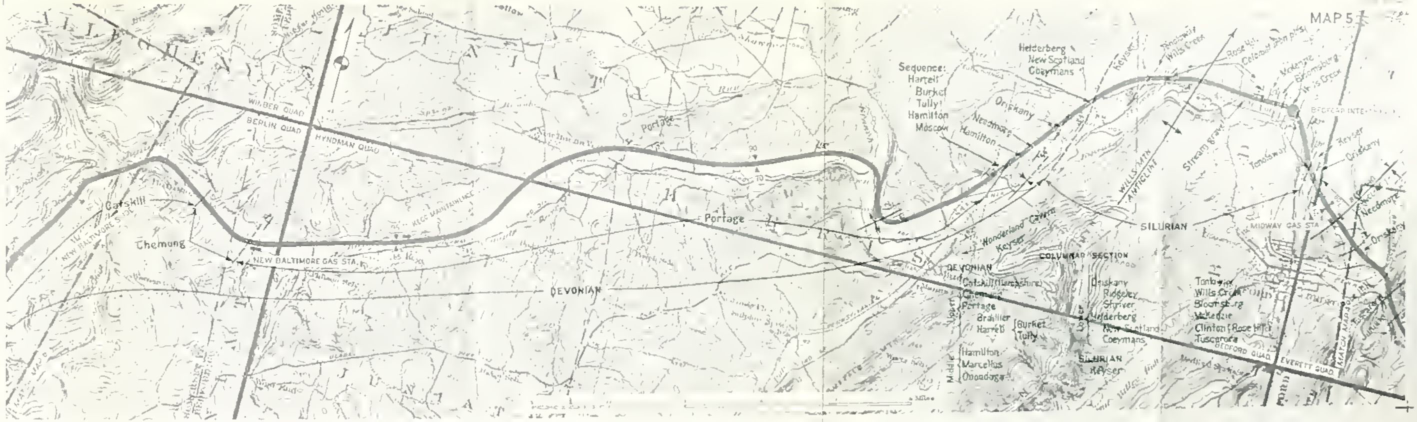


Plate 25 Pennsylvania Turnpike geologic strip map No. 5.

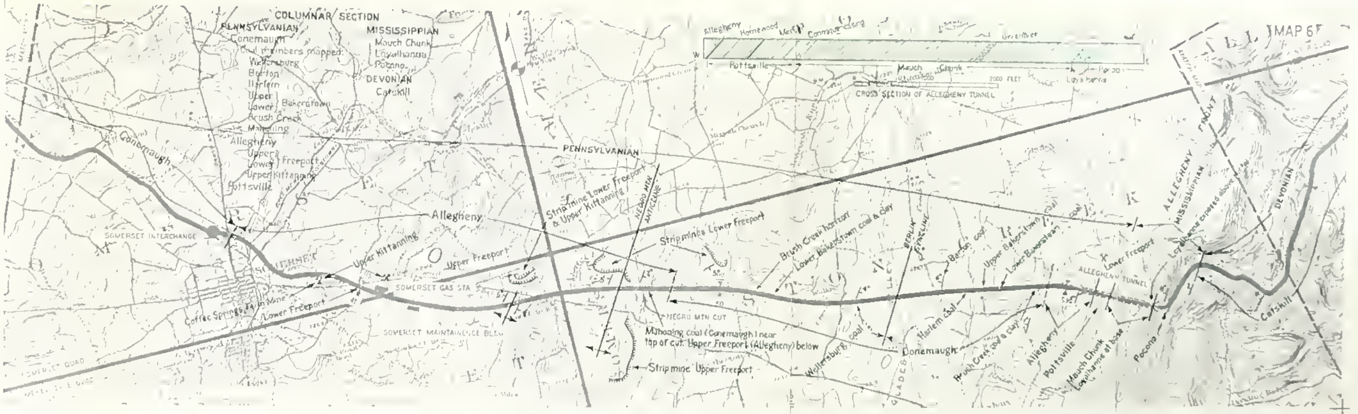


Plate 26. Pennsylvania Turnpike geologic strip map No. 6

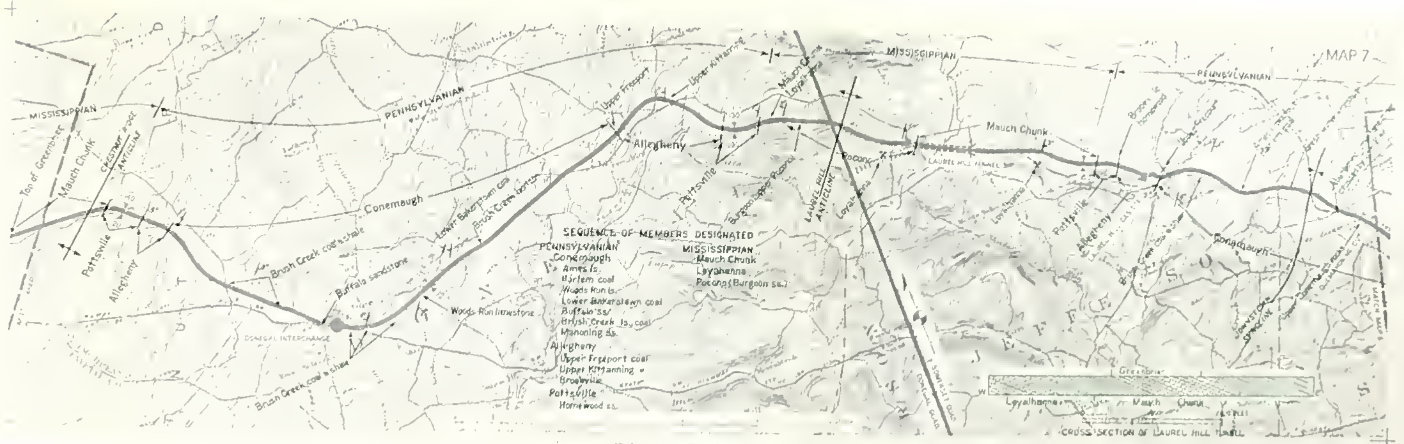


PLATE 27. Pennsylvania Turnpike geologic strip map No. 7

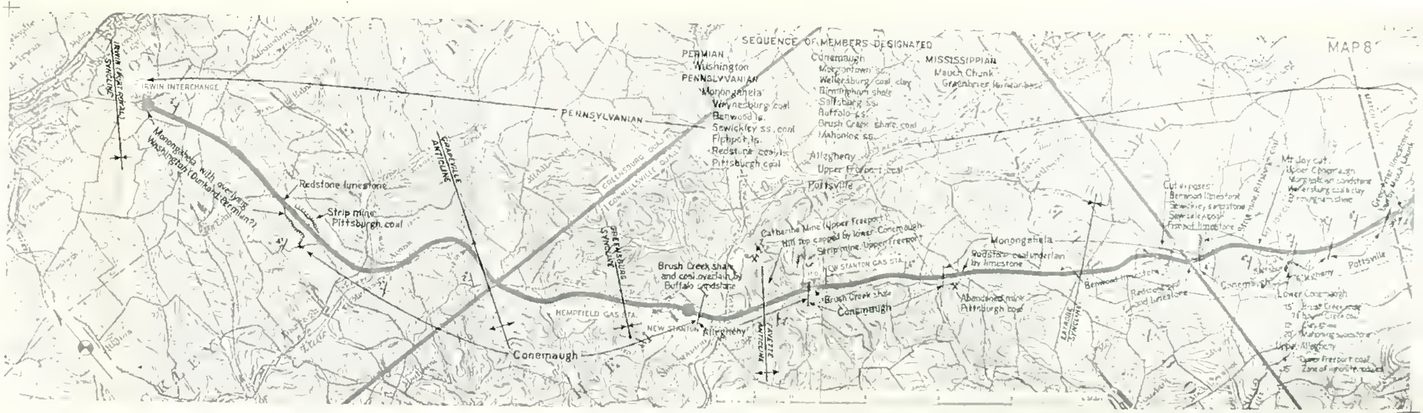


PLATE 28. Pennsylvania Turnpike geologic strip map No. 8.